Household's willingness to pay for safe drinking water: A case study of Abbottabad district

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March 2008

Household's Willingness to Pay for Safe Drinking Water: A Case Study of Abbottabad District

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Safe drinking water is the basic need of each human being. In the past 100 years the world population tripled, but water use for human purposes multiplied sixfold [Frank, et al. (2000)].

1. INTRODUCTION

Drinking water is the basic need of human life. Safe drinking water is an essential component of primary health care and have vital role in poverty alleviation. There is positive correlation between increased national income and the proportion of population with access to improved water supply. An increase of 0.3 percent investment in household access to safe drinking water generates one percent increase in GDP. Whereas, provision of safe drinking water supply is an effective health intervention reduces the mortality caused by water-borne diseases by an average 70 percent. Inadequate drinking water not only resulted in more sickness and deaths, but also augments health costs, lower worker productivity and school enrolment [World Bank (1994)].

The World Health Organisation (WHO) estimate 1.8 million people in developing countries die every year from diarrhea and cholera, Out of these 90 percent are children under the age of five years. While 88 percent of diarrhoeal diseases are attributed to unsafe water supply, inadequate sanitation and hygiene [WHO (2004)]. The situation is not very different in Pakistan; the access to safe drinking water is estimated to be available to 23.5 percent of population in rural areas and 30 percent in urban areas. While every year 0.2 million children die due to diarrhoeal diseases [Rosemann (2005)].

The annual presage estimated cost of environmental and natural resource degradation and damage is about Rs 365 billion which is one billion rupees per day or six percent of GDP. These estimates are based on those parameters for which reasonable estimates are available. The highest cost of Rs 112 billion is from inadequate water supply, sanitation, and hygiene [World Bank (2006)].

It is imperative to understand the safe drinking water supply situation, household's perception about it and their willingness to pay for safe drinking water. The focal district for the study is Abbottabad where the IUCN/PIDE, Environmental Fiscal Reform (EFR)

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project is initiated. The district has great potential for anchoring the EFR initiative as well as piloting EFR projects. It has prepared "State of the Environment and Development" and "An Integrated Development Vision" during 2004 [IUCN (2004a, 2004b)].

There is an inadequate supply of safe drinking water in Abbottabad as of other districts of the country. The situation is further aggravating due the accelerate increase in population. Supply of water has always been one of the major problems in Abbottabad. The condition of water supply as well as of safe drinking water is further deteriorated in summer because a large flux of tourists visits the district. This creates huge gap between supply and demand of water. Therefore, it is important to understand the safe drinking water situation in the district. The following are the major objectives of the study:

- Willingness to pay (WTP) for improved services level.
- The WTP for water quality improvement.

The rest of the paper is organised as follows: Section 2 briefly overlooks at the literature of willingness to pay for drinking water. Section 3 discusses the theoretical framework of both contingent valuation method and averting behaviour approach. Section 4 analyses the water situation in the district. Section 5 discusses the empirical results of both models. Section 6 concludes.

2. LITERATURE REVIEW

Altaf, *et al.* (1992) focused on WTP for safe drinking water while Crocker, *et al.* (1991) provide a theoretical framework for valuing the benefits of preventing ground water contamination which shows the importance of the risk and location of contamination, the exposed population, and risk perceptions. Chowdhury (1999) uses the contingent valuation method to estimate Dhaka Slum-dwellers willingness to pay for safe drinking water. The finding of the studies illustrate that slum dwellers are willing to pay enough for water to cover the costs of providing it, suggesting that higher water charges would be a financially feasible to generate funds for water system investment. Secondly the study shows that contingent valuation is an effective tool for estimating willingness to pay for a Varity of public services.

Bergstrom, *et al.* (1996) provides a conceptual model which describes the linkages between changes in groundwater quality and the services that are received by households. Whitehead, *et al.* (1998) describe the averting behaviour approach to the valuation of drinking water quality. Abdallah, *et al.* (1992) studied the cost of water pollution in Pennsylvania using averting expenditure increase of household to cope for the contamination and conclude that estimate obtained through averting expenditure analysis gives estimates that can be used for the ground water policy decisions. Since the averting expenditure method has also been established as a common method for the estimation of willingness to pay for household drinking water.

Harrington, *et al.* (1989) made an empirical study of Pennsylvania and find that 98 percent of the sample reported changes in their water consumption including combinations of hauling water, boiling water and/or purchasing bottled water. Averting expenditures range $153–$483 per month (1996 dollars).

Whitehead, *et al.* (1998) surveyed Gaston County, North Carolina, and use the averting behaviour approach and find that respondents who are concerned about risks to

health from ground water pollution are 1.67 times more likely to use a water filter. Respondents who rate their water quality as fair or poor are 2.4 times more likely to use water filter. While Collins, *et al.* (1993) examined the actions taken by households in rural West Virginia in response to test that revealed several contaminants in drinking water supplies. The most common types of action was to clean and /or repair the water system, haul water, install treatment systems, boil water, use a new water source, and /or correcting the contamination source. The average household cost of defensive behaviour ranged from $32 and $36 per month for bacterial and mineral contaminants. The total household cost related to organic contaminants was $109 per month.

Laughland, *et al.* (1993) estimate averting expenditures for households in Milesburg and Boggs Township, Pennsylvania who experience a surface water contamination episode. During the three-month boil water advisory most (91 percent) of the respondents boiled, hauled, or purchased water. The average monthly household defensive expenditures ranged between $16 and $35.

Abrahms, *et al.* (2000) use the multinomial model of averting behaviour in response to water contamination risks for Geogia residents. According to his estimation that perceived risk from tap water, concern about water quality (taste, odor, and appearance of tap water), race and age are the most important determinants of bottled water selection. Informations regarding current or prior problems with tap water, perceived risk from tap water, and income are the most important determinants of water filter selection. Adjusting for quality differences between tap and bottled water, he show that averting costs estimates using bottled water expenditures would lead to an overstatement of avoidance costs by about 12 percent. Smith and Desvousges (1986) find that Boston residents are more likely to install a water filter and purchase bottled water if they perceive that drinking water contamination risks associated with hazardous waste pollution are high.

3. THEORETICAL FRAMEWORK

Basically two theoretical approaches the (direct and indirect) are used for making reliable estimates of household's WTP for improvement in service and quality of water [Abdallah, *et al.* (1992)].

(i) the direct approach uses stated preference in which simply directly ask individual how much he or she would be willing to pay for the improved water service. This is called contingent valuation method (CVM).

(ii) the indirect approach uses data on observed water use behaviour (revealed preference) for averting the effects of inefficient and unsafe water qualities to estimate WTP. To survive the issue consumers develops various coping strategies. The coping cost give an estimate of how much additional money people are willing to pay for an improved quality.

3.1. Contingent Valuation Method

To consider the first objective "WTP for improved service level" we apply CVM. Contingent Valuation (CV) is a method of estimating the economic value of non-market environmental goods through survey questions that bring out individuals preferences regarding such goods [Carson (1989)].

 CVM surveys should carefully describe both quality levels and ask for respondent willingness to pay for the change in quality [Mitchell, *et al.* (1989)]. The basic assumption behind this method is to represents or valuing the objective quality improvement that the survey asks them to value.

In recent time CVM has been extensively applied in both developed and developing countries to the valuation of a wide range of environmental goods and services. CVM has been successfully applied to a variety of water related issues including sanitation, water supply [Susana (2002)].

Model for CVM

Water is a good which is not traded in the market (non-market good); therefore, non-market valuation method is required to estimate the WTP for water. Non market valuation attempts to estimate economic value in money term society receives from uses of resources.

Individuals have preferences over goods; both market and non-market, preferences of individuals are represented through utility functions. Consumers want to maximise his utility from quantity and quality of goods and services given his budget constraint.

The utility function $U(q, z)$

    q = water quality
    z = composite of all market goods

The expenditure function $e(p, q, u)$

The expenditure function measures the minimum amount of money the consumer must spent to achieve the given level of utility. The expenditure function is increasing function of 'P' and 'U' and decreasing function of 'q'.

Since consumer want to stay with the same utility, it is appropriate to use expenditure minimisation problem.

Min $(z + Pz)$ *s.t* $U = U(q, z)$ where price of composite goods are equal to one ($Pz = 1$).

The above minimisation problem can be solved using Lagrange's multiplier to obtain Hicksian demand for the corresponding goods.

The Hicksian demand is given by:

$$h_i = h_i(p_q, u^*)$$

Minimum expenditure function can be calculated by substituting the values of corresponding Hickisian demand in the minimum expenditure function:

$$e^* = e(p, q, u^*)$$

Where e is minimum expenditure required to achieve fixed level of utility u^* and using the water quality q, and is the function of price of other goods, the fixed level of utility and the quality of water itself.

The derivative of expenditure function with respect to price gives corresponding Hicks Compensated demand function for good under consideration.

$$\partial e/\partial p_i = h_i(p_q, u^*)$$

WTP for the change in water services is the integration of marginal *WTP* to achieve water quality from *q* to q^*

$$WTP = -\int_{q}^{q^*} \partial e\,(q,\,u^*)/\partial q \quad dq$$

WTP is the maximum amount of money consumer would give up in order enjoy an improvement in quality. The willingness to pay for the improvement in quality is

$$WTP = e\,(p,\,q,\,u) - e\,(p,\,q^*,\,u)$$

Where, *q* is a degraded level of quality and q^* is an improved level of quality.

The difference in expenditure is either compensating surplus or equivalent surplus, if the reference level of utility is initial utility it is compensating and if the reference level of utility is final then it is equivalent surplus. *WTP* depends on income, wealth, household education level; distance from existing sources etc. [Whittington, *et al.* (1990); Briscoe, *et al.* (1990), and Altaf, *et al.* (1992). To capture various determinants of *WTP* the following multivariate regression analysis is conducted.

$$WTP_i = \beta_0 + \beta_1\,(H_i) + \beta_2\,(D) + \beta_3\,(S_i) + u_i$$

Where:

WTP_i = Households' willingness for continuous and potable water supplies,
H_i = Households characteristics (Highest education level of the HH, income level of the HH),
D_i = Households demographic characteristics (urban, rural),
S_i = Service characteristics [time taken for fetching water (summer, winter), tap, well].

3.2. Averting Behaviour Approach

Averting behaviour model suggests that WTP depends on any variable that affect the marginal product of pollution, mitigating activities or avoidance cost [Freeman (1993)]. The economic effect of unsafe drinking water include change in the expenditures and well being in terms of medical costs, earning lost, lost production in the home, lost leisure time, and mitigating expenditures. Averting behaviour begin with the assumption that people make choices in order to maximise their level of well-being when faced with exposure to unsafe drinking water [Corpper and Oates (1991)].

Model for Averting Behaviour Approach

The study adopted the previous model used by Bresahan, Dickic, and Gerking (1997), Cropper and Freeman (1991), Freeman (1993), Smith (1991), and Whitehead, *et al.* (1998). The inadequate and unreliable water supply has made consumer to move towards more reliable alternatives. Therefore consumers engage in various averting behaviour to cope with unreliable water quality.

Suppose consumers engage in Varity of averting behaviour (Boiling water, installation of filter, use of water purification chemicals) with unreliable water quality.

The averting behaviour good provides utility indirectly through health production and therefore indirectly in the utility function (e.g. in case of boiling water, filtered water), we assume that individuals gain utility directly through the consumption of water and indirectly through the production of health). In the typical averting behaviour model, such as that developed by Courant and Porter, averting behaviour activities enter the utility function only through the production of health [Abrahams, *et al.* (2000)].

Consider a consumer with a utility function:

$$U(X, H, A, Q) \qquad \ldots \qquad \ldots \qquad \ldots \qquad \ldots \qquad \ldots \qquad \ldots \qquad \ldots \qquad (1)$$

Where X is a composite market good, H is health production function, A is averting behaviours (Boiling water, installation of filter, use of water purification chemicals) and Q is drinking water quality. Where $U_A > 0$ and $U_Q < 0$. Utility function is increasing in A if the averting behaviour (e.g. filter) improves the taste of water. Utility is decreasing in Q if pollution reduces the quality of drinking water. Healthy time is produced according to the production function

$$H = H\,(A, Q;\, M, K, D) \qquad \ldots \qquad \ldots \qquad \ldots \qquad \ldots \qquad \ldots \qquad \ldots \qquad (2)$$

Where, M is mitigating behaviour (e.g. doctor visits, medicine), K is health capital and D is human capital. Mitigating behaviour is assumed to occur after an illness has occurred and therefore mitigating behaviour does not affect the productivity of averting behaviour and quality, therefore H_{AM}, $H_{QM} = 0$.

The production function is twice differentiable and $H_A < 0$, that the health production functions is decreasing in A, $H_W > 0$ that health production function is increasing function of water quality. Averting behaviour and quality are imperfect substitutes. Substitution of health production function into the utility function yields the utility function expressed in the composite commodity, leisure, averting behaviour, and pollution:

$$U = U\,[X, H\,(A, Q),\, A, Q] \qquad \ldots \qquad \ldots \qquad \ldots \qquad \ldots \qquad \ldots \qquad \ldots \qquad (3)$$

Consumers face a budget constraint for market goods and a cost function for the production of healthy time. Income is a function of time spent in the labour market:

$$Y = w\,[T - H] \qquad \ldots \qquad \ldots \qquad \ldots \qquad \ldots \qquad \ldots \qquad \ldots \qquad \ldots \qquad (4)$$

Where Y is income, w is the wage; T is total work time available. The cost equation is the sum of expenditures on composite good X and averting strategies:

$$C = X + P_A A \qquad \ldots \qquad \ldots \qquad \ldots \qquad \ldots \qquad \ldots \qquad \ldots \qquad \ldots \qquad (5)$$

Where $P_X = 1$ and P_A is the market price of averting strategy:

$$P_A = P_A + w t_A \qquad \ldots \qquad \ldots \qquad \ldots \qquad \ldots \qquad \ldots \qquad \ldots \qquad \ldots \qquad (6)$$

Where P_A is the market price and t_A is time spent conducting the behaviour. Equating the income and cost equations yields the full income budget constraint:

$$wT = X + P_A A + wH\,(A, Q) \qquad \ldots \qquad \ldots \qquad \ldots \qquad \ldots \qquad \ldots \qquad \ldots \qquad (7)$$
$$Y = C$$

The consumer faces the following problem:

$$max\ U = U\ [.]\ s.t\ Y = C \qquad \ldots \qquad \ldots \qquad \ldots \qquad \ldots \qquad \ldots \qquad \ldots \qquad (8)$$

First-order conditions for utility maximisation can be derived from LaGrange function:

$$L = U\ [\ X, H(A,Q), A, Q] + \lambda\ [wT - X - P_A A - wH(A,M,Q)] \qquad \ldots \qquad \ldots \qquad (9)$$

Assuming second-order conditions are satisfied, the first-order conditions for maximum are:

$$L_X = U_X - \lambda = 0 \qquad \ldots \qquad \ldots \qquad \ldots \qquad \ldots \qquad \ldots \qquad \ldots \qquad \ldots \qquad (i)$$

$$LA = U_H H_A + U_A - \lambda\ (\ P_A + wH_A) = 0 \qquad \ldots \qquad \ldots \qquad \ldots \qquad \ldots \qquad (ii)$$

$$L_Q = U_H H_Q + U_Q - \lambda wH_Q = 0 \qquad \ldots \qquad \ldots \qquad \ldots \qquad \ldots \qquad \ldots \qquad (iii)$$

$$L_\lambda = wT - P_X X - P_A A - P_M M - w - wH\ (.) = 0 \qquad \ldots \qquad \ldots \qquad \ldots \qquad \ldots \qquad (iv)$$

Rearranging first-order condition (ii) yields the averting behaviour condition for the utility maximum:

(ii) $(U_H H_A + U_A)/\lambda - wH_A = P_A + wt_A$

Where the left-hand side of (iv) is the marginal benefits of averting behaviour and the right-hand side of (ii) is the marginal cost of averting behaviour. Individuals will pursue averting behaviour until the sum of the marginal value of healthy time, the marginal value of averting behaviour and the opportunity cost of healthy time is equal to the market and time costs of averting behaviour. Since the wage rate appears on both sides of (ii) it is difficult to determine the effect of the wage rate on the averting behaviour. The overall effect depends on the relative magnitude of the amount of time required to engage in averting behaviour and the marginal product of averting behaviour. An increase in quality will decrease the marginal benefit of averting behaviour if averting behaviour and quality are imperfect substitutes. Rearranging first-order condition of (iii) yields the quality condition for a utility maximum:

$$(U_H H_Q + U_Q)/\lambda - wH_Q = 0 \quad \ldots \qquad \ldots \qquad \ldots \qquad \ldots \qquad \ldots \qquad \ldots \qquad (v)$$

Individuals will avoid pollution until the sum of the marginal value of healthy time, the marginal value of quality and the opportunity cost of healthy time is equal to zero. The first order conditions can be solved for the averting behaviour function:

$$A^* = A^*(P_A, w, Q) \quad \ldots \qquad \ldots \qquad \ldots \qquad \ldots \qquad \ldots \qquad \ldots \qquad \ldots \qquad (10)$$

The effect of the wage rate on averting behaviour is indeterminate since the full price of averting behaviour and the opportunity cost of sick time are both functions of the wage. An increase in the wage increases the cost of averting behaviour, decreasing the pursuit of averting behaviour, and increases the cost of sick time, increasing the pursuit of averting behaviour. Similar expression can be obtained for the demand for leisure and mitigating behaviour. Substitution of the optimal values of averting and mitigating behaviours and leisure into the utility function yields the indirect utility function:

$$V = V (P_A, PM, W, Q) \qquad \dots \quad \dots \quad \dots \quad \dots \quad \dots \quad \dots \quad (11)$$

The above indirect utility function is decreasing in the prices and increase in the wage and quality. Totally differentiating the indirect utility function yields:

$$dV = V_{PA}dP_A + V_W dw + V_Q dQ \qquad \dots \quad \dots \quad \dots \quad \dots \quad \dots \quad (12)$$

The total derivative of quality is:

$$dV/dQ = V_W (dw/dQ) + V_Q \qquad \dots \quad \dots \quad \dots \quad \dots \quad \dots \quad (13)$$

Holding utility constant, the marginal value of a change in water quality is again:

$$WTP_Q = dw/dQ = -v_{Q/\lambda} \qquad \dots \quad \dots \quad \dots \quad \dots \quad \dots \quad (14)$$

Since, at the maximum utility level, first-order condition (iii) can be interpreted as the marginal utility of pollution:

(iii) $V_Q = (U_H - \lambda w) H_Q + U_Q = 0$

and since the first-order condition for averting behaviour (ii) can be expressed as:

(ii) $U_H - \lambda w = (\lambda P_A - U_A)/H_A$

Substitution of (ii) into (iii) yields the marginal value of quality:

$$VQ/\lambda = P_A (H_Q/H_A) - (U_A/\lambda) (H_Q/H_A) + U_Q/\lambda \quad \dots \quad \dots \quad \dots \quad \dots \quad (15)$$

Shows that with joint production of the averting good and a non-zero marginal utility of quality the marginal value of quality is greater than the marginal value of quality without joint production and marginal utility of quality equal to zero. With joint production increased pollution will increase averting behaviour, which lowers the marginal value of quality. With joint production and non-zero marginal utility of quality, the marginal value of quality can no longer be estimated with knowledge of the production function and market prices. Substitution of the optimal values of $A^*(.)$ and $M^*(.)$ into the health production function and totally differentiating yields:

$$dH = H_Q dQ + H_A dA^* \qquad \dots \quad \dots \quad \dots \quad \dots \quad \dots \quad (16)$$

Dividing the total differential by dQ yields the total derivative for the effect of quality on health

$$dH/dQ = H_Q + H_A (dA^*/dQ) \qquad \dots \quad \dots \quad \dots \quad \dots \quad \dots \quad (17)$$

The total effect is the sum of a direct effect and two indirect effects. The direct effect is the marginal product of pollution on healthy time (H_Q). The indirect effects are the products of the marginal product of averting behaviour on healthy time and the marginal effect of pollution on averting behaviour. Multiplying both sides of (17) by w yields an expression for the opportunity cost of illness:

$$w (dH/dQ) = w[H_Q + H_A(dA^*/dQ)] \qquad \dots \quad \dots \quad \dots \quad \dots \quad \dots \quad (18)$$

This expression shows with averting behaviour in the choice set the opportunity cost of illness is smaller since $H_A (dA^*/dQ) > 0$. Rearranging the total differential:

$$dH/dQ - H_A (dA^*/dQ) - H_M (dM^*/dQ) = H_Q \qquad \dots \quad \dots \quad \dots \quad \dots \quad (19)$$

Multiplying by the first-order condition (iii)

(iii) $(U_H + U_A)/\lambda - w = P_A/H_A$

$[dH/dQ - H_A (dA^*/dQ)] [(U_H + U_A)/\lambda - w] = P_A (H_Q/H_A)$ …   …   (20)

and since $P_A = H_A [U_H + U_A/\lambda - w]$; from first order conditions (iii) and (iv)
$WTP_Q = -P_A (H_Q/H_A)$

$= -(dH/dQ) (U_H + U_A)/\lambda + w (dH/dQ) + P_A (dA^*/dQ)$ …   …   …   (21)

The marginal willingness to pay for quality is the sum of the non-market value of the disutility of non-healthy time and the aesthetic value of quality, the opportunity cost of illness, and averting expenditures after the optimal adjustment to the quality change.

4. SITUATION ANALYSIS IN ABBOTTABAD

The data used in the study was collected by PIDE survey team from district Abbottabad during 2007-08. Systematic random sampling technique was adopted for the collection of data. Four hundreds and fifty five households, which consist of 2779 households' members, were interviewed at their premises through a well structured and pre tested questionnaires. According to the 1998 census, total population of the district is 881 thousands in which 17.9 percent (158,000) live in the urban while 82.07 percent (723,000) in rural area of the district. Abbottabad have two Tehsils "Abbottabad" and "Havelian" with 35 and 16 Union Councils, respectively.

The drinking water system of the district are running by the public health engineering department (PHED) apart form PHED ten more public sector organisations including the District Council (DC), the Municipal Committees(MCs), the Cantonment Boards(CBs) etc are playing their role in water supply. The PHED is the core public sector agency that provides water in the rural apart from this, District Council is also actively participating in the provision and distribution of water in the rural areas. According to data compiled by these agencies, about 62 percent of the rural and 88 percent of the urban population have access to the water supply schemes.

Table 1

Demographic Characteristic of District Abbottabad

Tehsil	Area(Acre)	Population		Avg: HH size	No. of Ucs
		Male	Female		
Abbottabad	236367	278868	283789	6.03	35
Havelian	126261	113875	124058	6.26	16

Out of the total sample households 40 percent were from the rural area while the rest 60 percent from urban. The ratio of respondents was 80:20 between Abbottabad and Havelian Tehsils. The survey revealed that in both urban and rural areas, public sector is the major supplier of tap water, which supplies 92 percent in urban and 65 percent in rural areas. Communities (26 percent) are playing vital role in providing of tap water at home in rural areas.

The source of drinking water amongst the survey households was 26, 16, 20, and 18 percent using springs, streams, wells, and government water tanks in rural areas, respectively. While it was 3.6, 4.6, and 88 percent springs, wells, and government water tanks in urban area, respectively.

Highest education level in the household is used as an explanatory variable in both models (CVM, ABM). Five categories of education based on years of education were made i.e. illiterate (0), 1–5, 6–10, 11–14 and 15 and above years. The percentage level of all five categories in both urban and rural areas is presented at Table 2.

Table 2

Highest Level of Education in HH

Categories	Rural	Percentage	Urban	Percentage
0	4	2.3	3	1.1
1–5	21	12.1	11	4
6–10	88	51	67	24
11–14	53	30.6	141	50
15 and above	7	4	67	21
Total	173	100	282	100

The second indicator is income level of the household which we have ranged in four quartiles q_1 (lower income), q_2 (lower middle), q_3 (upper middle), q_4 (highest). The percentage distribution of the sample HHs were 27.7, 22.4, 26.2, and 23 in first q_1, second q_2, third q_3, and in the last q_4 quartile, respectively.

One important indicator is source of water, for this respondent has asked whether they have their own water source. The survey discovered that only around eight percent HHs have their own water source, which was only 14.6 and 3.5 percent in rural and urban areas, correspondingly.

The overall distribution of different sources of drinking water was 69.2, 7.7, 37.4 percent from tap, well, and fetching in the district, respectively. Its distribution in rural and urban area was 19.4 and 80.6 percent for tap water, 71.4 and 28.6 percent for well, and 70.6 and 29.4 percent for fetching water from outside.

Seventy five percent HHs responded about the quality of the drinking water which was based on unfavourable taste, smell or appearance while out of these substantial (38 percent) number of the respondents was not satisfied about the drinking water quality. The complaint was found higher (39 percent) amongst urban HHs as 35 percent of rural HHs.

The survey respondents were found well aware about the significance of safe drinking water because 58 percent of overall respondents were adopting safe drinking water practices. This is found higher (65 percent) in rural areas as of urban (54 percent). The results are quite rational because it reflects that in rural areas there is poor supply of safe drinking water as of urban areas. The major practice adopted for cleaning of water was found as boiling (30 percent in rural and 27 percent in urban), use of filter (24 percent rural and 20 percent urban), while the use of chemical (10 percent in rural and 7 percent in urban).

To measure people's perception about WTP for improved water services the question was split in to four categories i.e. not willing to pay, willing to pay from Rs 1–50, willing to pay in rang of Rs 51–100 and willing to pay higher than Rs 100 per month.

The over all sample results revealed that 70 percent of the respondent of Abbottabad district were willing to pay for safe drinking water supply. The response was found higher amongst the urban respondent (92 percent) as of rural (69 percent). The lower level of WTP in rural area may be due to their low income level, having own sources of drinking water, and low level of education.

In rural areas where 50 percent of HH were WTP in the range of Rs 1–50 for improving of water services while it was found 25 percent WTP in urban area. The third category (i.e. from Rs 51 to 100) is dominating in the urban areas where 56 percent are willing to pay, while in rural area just 20 percent are willing to pay in this range. This might be due the difference in the sources and availability issues at the urban areas. Finally the fourth category, which comprises of those who are willing to pay above Rs 100 per month, is represented by 10 percent in urban while only 2 percent in the rural areas.

5. EMPIRICAL RESULTS

5.1. Contingent Valuation Model

Multinomial Logistic model is used to estimate the effects of the independent variables on the dependent variables (WTP) which is categorised in three different groups. The first one consists of HHs which are WTP 50 or less, the second category comprise of HH, which are willing to pay in the range of 51–100 for improved water services and the last category is described HHs who are WTP above 100 rupees per month in order to get improved water services.

Location (rural, urban) significantly affects people's WTP as in the urban areas HHs are more WTP for improved water services. As we have discussed earlier, urban dwellers are more dependent on government sources and own source of water is almost negligible that's why they are more desperate for improvement in their current water system. Another important element is the negative sign of the coefficient for the first group WTP i.e. 1–50. This negative relationship can be interpreted as those, living in the rural areas, are more WTP in this range as compared with the urban dwellers. While the other two groups with higher WTP have positive coefficients which suggests that urban respondents are more WTP in this range as compared with the rural respondents (Table 3).

The results for those who have their own water source are very interesting. WTP for the first two groups are significant. However, WTP for the first two groups it has negative sign. It suggests that there is a negative relationship between the two variables. People who have their own water source have no inclination to pay in this range. But on the other side they are willing to pay in the higher range i.e. 51–100 per month. This may be due to their higher demand for improved water services despite they have their own water source. This can be justified on the basis of cost involve in digging well and relatively higher maintenance/operating costs (motor pump, electricity consumption etc) which they are current bearing therefore they have higher WTP. The recent high electric power rate and load shedding further support the finding.

Table 3

Estimated Parameters of WTP (CVM)

Independent Variables	Dependent Variables Willingness-to-pay		
	Rs 1–50	Rs 51–100	Rs >100
Location (Urban/Rural)	–0.332*	0.578*	0.015*
	(0.000)	(0.000)	(0.022)
Water Source (well)	–0.224*	0.255*	0.016
	(0.004)	(0.010)	(0.354)
Water Source (Tap)	0.169*	–0.300*	0.006
	(0.019)	(0.000)	(0.418)
Second Income Quartile	0.086	–0.104	–0.005
	(0.250)	(0.177)	(0.365)
Third Income Quartile	–0.051	0.047	–0.005
	(0.487)	(0.552)	(0.365)
Fourth Income Quartile	0.045	0.005	–0.005
	(0.574)	(0.948)	(0.313)
Average Time Taken for Fetching Water	–0.001	0.001	0.000
	(0.615)	(0.652)	(0.932)
Metric (Highest Level of Education of HH)	–0.431*	–0.339*	1.000*
	(0.000)	(0.000)	(0.000)
Graduation (Highest Level of Education of HH)	–0.455*	–0.309*	0.999*
	(0.000)	(0.000)	(0.000)
Post-graduation (Highest Level of Education of HH)	–0.406*	–0.395*	0.999*
	(0.000)	(0.000)	(0.000)
Log Likelihood	–475.029		
Number of Observation	455		
LR chi2(30)	158.17		
Prob > chi2	0		

Probabilities of critical values are reported in parentheses.
* Indicates significance at 5 percent level.

Tap water significantly affects WTP, for the first two categories (50 or less and 51–100).However the second category have a negative coefficient which implies that people having tap water are less WTP higher amount for improved services this might be due to the bad experience with the current water quality. For the third category of WTP i.e. HH willing to pay above 100 rupees per month, is statistically insignificant for those who have tap water at home. The income levels of the HH have also insignificant effect on WTP. This shows that people's WTP is not influenced directly by their income levels.

People who do not have any water availability at home used to fetch from outside sources for their daily uses. Average time they consume for fetching water is taken as the explanatory variable which surprisingly have no statistically significant effect on willingness to pay for improved water services.

Education level has direct bearing on the WTP for safe drinking water. According to the preliminary results, relationship between the different categories of WTP and levels of education (1–5, 6–10, 11–14 and above 15) is statistically significant. At all levels of education they are willing to pay above Rs 100 per month, which suggests that there is greater awareness and rationality in the people who have some sort of education. For the lower categories of WTP (i.e. 1–50 and 51–100) are significant but have negative coefficients which can be attributed to the view that they think its government responsibility to provide safe water to the masses.

5.2. Averting Behaviour Model

Like CV model, in averting behaviour model Multinomial Logistic model is used to estimate the effects of explanatory variables on the dependent variables i.e. (filter, boiling, chemical) respectively.

The empirical results revealed that for the first strategy (Filter), the first two income quartiles q_2 (lower income) q_3 (lower middle) are insignificant, while the last quartile (highest income) is significant. This is quite acceptable as filters are considered as a bit costly and require regular maintenance, that's why it is clear that filters can not be used by the middle income groups. In addition, other variables, location (urban, rural), number of children in the HH and sources of water (well, tap, fetch) have insignificant effect at (5 percent) on the households' filter installation strategy (Table 4).

The dummy for the location is insignificant in our analysis for filter. This suggests that there are other variables which are more important to determine the use of filter. We have also used number of children as an explanatory variable; it is generally believed that HHs is more conscious in water purification if they have more children. But the results are not supporting this perception. However, in source of water (tap), is significant at 10 percent level. The water quality have a significant effect on the HH's decision about filter which shows that in case of unfavourable water quality (unfavourable taste, smell or appearance) use of filter is high. Similarly, awareness regarding health hazards due to unfavourable water quality is also an important variable. In the case of filter, awareness is also highly significant which suggests that awareness play an important role in adopting averting behaviour like filter. Lastly, the highest education level of the HH has a significant effect on the dependent variable (filter). All four categories representing primary, secondary, graduate and post graduate levels have a significant effect on installation of filter for the purification of drinking water (Table 4).

Same like filter for the Second strategy (Boiling), the first two quartiles of income q_2, q_3 of income are insignificant, while q_4 (higher income) is significant. This may be the reason that to some extent cost is involve in water boiling therefore, only the highest income quartile has a significant results, while the other two have insignificant effect at the 5 percent level of significance moreover , the middle income quartile is significant at 10 percent level.

Table 4

Marginal Effects of Multinomial Logit Regression

Independent Variables	Dependent Variables Averting Strategies		
	Filter	Boiling	Chemical
Second Income Quartile	–0.070	–0.087**	–0.024
	(0.192)	(0.083)	(0.283)
Third Income Quartile	–0.068	–0.077	–0.038**
	(0.220)	(0.132)	(0.075)
Fourth Income Quartile	–0.123*	–0.105*	–0.047*
	(0.018)	(0.038)	(0.020)
Location (Urban/Rural)	0.003	–0.065	–0.072*
	(0.963)	(0.295)	(0.048)
Number of Children in Household	0.006	–0.007	–0.006
	(0.623)	(0.573)	(0.382)
Water Source (Well)	0.043	–0.047	–0.001
	(0.629)	(0.495)	(0.983)
Water Source (Tap)	–0.130**	–0.196*	0.057*
	(0.058)	(0.003)	(0.006)
Water Sources (Fetching)	0.047	–0.148*	–0.047*
	(0.389)	(0.002)	(0.044)
Satisfaction from Quality of Water	0.135*	0.198*	–0.040*
	(0.025)	(0.001)	(0.044)
Awareness about Waterborne Diseases	0.175*	0.079**	0.017
	(0.000)	(0.087)	(0.464)
Primary (Highest Level of Education of HH)	–0.303*	0.778*	0.129**
	(0.000)	(0.000)	(0.090)
Metric (Highest Level of Education of HH)	–0.336*	0.807*	0.193*
	(0.000)	(0.000)	(0.035)
Graduation (Highest Level of Education of HH)	–0.239*	0.855*	0.144*
	(0.001)	(0.000)	(0.030)
Post-graduation (Highest Level of Education of HH)	–0.310*	0.813*	0.165
	(0.000)	(0.000)	(0.142)
Log Likelihood	–511.075		
Number of Observation	455		
LR chi2 (42)	120.46		
Prob > chi2	(0.000)		

Probabilities of critical values are reported in parentheses.
* Indicates significance at 5 percent level.
** Indicates significance at 10 percent level.

Location, number of children, and source of water has insignificant effect on the HHs' water boiling strategy. This can be attributed to the reasoning that HH who have their own source of water (e.g. well) are mostly satisfied from the quality and therefore, not adopt any measure for safety of water. Similarly, demographic characteristics (rural, urban) are also insignificant. This means that the HH averting behaviour for safety of water is not influenced by the demographic location. In case of source of water (tap, fetch) have a significant effect on HH boiling strategy. This can be attributed to the lower quality of water, available from these sources of water. This argument is also supplemented by the next independent variable i.e. water quality (taste, smell, appearance) which is highly significant in this equation. So people are unsatisfied with these sources of water and are therefore using more of boiling technique to counter it. As far as awareness in this equation is concerned, it is significant at 10 percent level. Boiling of water is used identically in all those people who have some level of education (Table 4).

In the case of third category (Chemical), the third and fourth quartiles of income are significant at 10 and 5 percent levels, respectively. Location is also significant at 5 percent. As far as the sources of water are concerned again those who have their own source of water (well etc.) do not use any water safety measure and they seems to be satisfied with their water quality, so results are insignificant when the source of water is well. On the contrary, people getting water from other sources (tap, fetch from outside) uses chemical and results are significant (5 percent) for these sources. The results for the quality of water are also significant (5 percent), which suggests that if people are unsatisfied with the quality of water they would use more of averting behaviour techniques. This can also be interpreted as those who have water availability from sources like tap or they fetch from out side, are unsatisfied with their water quality. Hence people feel that the quality they are receiving is not safe and resultantly they adopt certain measures for the safety of water.

Awareness indicator is insignificant where as the use of chemical is significant at each level of education i.e. primary (at 10 percent), metric and graduate (at 5 percent). Thus the level of education do interfere the public decision to adopt certain averting behaviours.

6. CONCLUSION

The existing system of drinking water in Abbottabad is not reliable in both services and quality to meet the requirements of the HHs. The study measures WTP for improved water services and averting behaviour for quality improvement of drinking water. The results indicate that reliability of both water services and quality is of value to the HHs. Both services and quality are important such that HHs are willing to pay for improved water services and also adopts averting behaviour for improved water quality.

For the HH's WTP for improved water services, the study estimates that there is statistically significant effect of location that in urban areas, HHs has more WTP for improved water services. The study also finds that sources of water have a significant effect on WTP i.e. the HH who have own source are willing to pay in the higher range (Rs 51–100) further tap water has significant effect on WTP for the first two quartiles. As expected, education level significantly affects WTP for safe drinking water.

In averting behaviour strategies (Filters, Boiling, Chemical) for quality improvement, the study finds that there are statistically significant effects of education on the water purification behaviour of the HHs. Interestingly, higher income quartile is highly significant in all strategies, while in source of water people getting water from tap or fetch from outside, is highly significant in both boiling and chemical. But tap is significant in filter use at 10 percent level of significance.

As expected, the study finds that there is a strong effect of quality (unfavourable taste, smell, appearance) on all water purification behaviour of HHs i.e. water quality is highly significant in all strategies. Apart from above variables, awareness has an effective role in influencing the general public perception towards the opportunity cost for using unsafe water.

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