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Abstract

Adequacy and quality are crucial for household water supply. One of the major problems with public utilities such as drinking water in developing countries is intermittent, insufficient and unreliable supply. Nepal is no exception to this. Water is not supplied round the clock, pressure is insufficient to pump it to the tap and the amount of water made available to the public, whatsoever, is not directly potable. To combat these problems, households engage in a variety of coping behaviors. Some of the major strategies for coping with intermittent and unreliable water supply are collecting, pumping, storing, treating and purchasing. This paper estimates the cost of coping with unreliable public water supplies and willingness to pay for improved water supplies in Kathmandu valley. Coping costs are calculated from respondents' answers on averting behavior, market price and value of time. Willingness to pay for improved water supply is calculated using stated preference method and compared with the value obtained from revealed preference method. The paper also discusses effects of socio-economic characteristic of household on coping cost and willingness to pay for improved water supply.

Keywords; Willingness to Pay, Coping Cost, Revealed Preference, Stated Preference

1. Introduction

Adequacy and quality are crucial for household water supply. Safe and affordable supply of drinking water is basic need for human life. There is positive correlation between increased national income and the proportion of population with access to improved water supply. A 0.3% increase in investment in household access to safe water is associated with a 1% increase in GDP (World Bank 1994). Unreliable supply, shortage of water and poor quality of water affects life of human being in various ways. Of the 6 billion people on earth, more than one billion i.e. one sixth lack access to safe drinking water. Goal 7, target 10 of Millennium Development Goal (MDG) aims at reducing the proportion of people without sustainable access to safe drinking water and basic sanitation to half by 2015 (Millennium Development Goal Report 2007). Thus household water supply has become an important public policy issue.

According to Report on Water Survey of Kathmandu-2005, per capita per day water consumption in Kathmandu is 35 liters and water demand is 44 liters (CBS -2005). These data show that not only consumption but demand for water as well is quite low as compared to average demand in other developing cities. Thus supply of water has always been one of the major problems in Kathmandu i.e. there is a huge gap between supply of and demand for water. During dry summer months the population of Kathmandu valley faces chronic water shortage. Nepal Water Supply Corporation (NWSC) produces about 120 Million Liters per Day (MLD) during wet season but only 80 MLD during dry season. Much of water that is produced is lost before it reaches the NWSC's consumers (Whittington et al. 2002).

A full service water supply system delivers water at the consumers tap with continuous flow. Most of the water utilities authorities in developed countries supply continuous and potable drinking water for 24 hrs a day. Continuous supply and enough pressure available in the system are not only convenient but also help to prevent water borne deceases. One of the major problems with public utilities such as drinking water in developing countries is intermittent, insufficient and unreliable supply. Nepal is no exception to this. Water is not supplied round the clock, pressure is insufficient to pump it to the tap and the amount of water made available to the public, whatsoever, is not directly potable. To combat these problems, households engage in a variety of coping behaviors. Some of the major strategies for coping with intermittent and unreliable water supply are collecting, pumping, storing, treating and purchasing.

One of the central issues in economics is that the purpose of economic activities is to increase the wellbeing of individual who constitute society, in other words economics should focus on maximizing social welfare (Freeman 1993). Consumer welfare gives a measure of society's welfare. Policy design for improving household water supply needs evaluation of social benefits and costs. Even being one of the major areas of economics, not much focus has been given to analyze consumer welfare due to improvement in water quality, especially in the context of developing countries.

Consumption of goods and services available in market is a determinant of the welfare that consumer attains. And the relation between amount of good consumer desires and price consumer pays is given by downward slopping demand curve. Demand curves for market goods are derived from the equilibrium price and goods demanded from which consumer surplus can be calculated. Such demand curve showing price quantity combinations are generally associated with goods for which market exists. But for the goods that do not come under market transaction such as water, demand curve cannot be derived from the equilibrium in the market.

Two basic approaches are used to estimate household's Willingness to Pay (WTP) for improvement in quality of water. First one is indirect approach, which uses revealed preference i.e. observed behavior for averting the effects of insufficient and unsafe water services to estimate WTP. If water is not sufficient and reliable, households will develop various coping strategies to satisfy their needs and coping cost is the amount of additional money consumer would pay for an improved service. Thus it gives an estimate of how much additional money people are willing to pay for an improved service (Abdalla et al. 1992). Second approach known as direct approach uses stated preference i.e. consumer's direct response to estimate willingness to pay for better service.

Many recent studies based on contingent valuation methods (CVM) consider overestimation of demand as a very significant factor for the failure of development project (Zarah M. H. 2000). Moreover, CVM, based on hypothetical scenarios are biased (Cummings et al. 1986). Current study attempts to go one step further and estimate WTP for improved water supply using stated preference method and compare it with the value obtained from revealed preference method. Estimation of WTP using revealed preference method is based on revealed coping cost. Estimation of WTP using stated preference method is based on contingent valuation survey. Structural consistency across the two models is tested. The paper also discusses effects of socio-economic characteristics of household on coping cost and willingness to pay for improved water services.

Our result shows that demand for water and WTP are significantly high in Kathmandu. Mean WTP per month is Rs 126.11 as compared to current tariff of Rs 60.11 and demand is 40.84 Liters Per Capita per Day (LPCD) as compared to current consumption of 33.19 LPCD. Coping costs are statistically correlated with water tariffs and many household characteristics. Results for coping cost and WTP imply that consumers are eager to improve the quality of water service and water utility levies can be increased to improve the water service. Our finding suggests that the two methods offer similar but statistically different results.

Rest of the paper will proceed as follows. We will discuss about the background of water supplies situation in section 2, literature for stated and revealed preference methods will be reviewed in section 3. In section 4, we discuss simple theory related to WTP and coping cost and in section 5, we discuss the results. In section 6, we conclude.

2. Background

Kathmandu Valley, the capital city of Nepal inhibits more than 1.5 million people with 220000 households (Disaster Risk Management Profile-2005). It includes five major cities:Kathmandu, Lalitpur, Bhaktapur, Kirtipur, and MadhyapurThimi. Total demand for water in Kathmandu valley is more than 200 MLD. At the moment, Nepal Water Supply Corporation (NWSC) is supplying about 80 (MLD) during dry season and 120 MLD during wet season. Much of water, approximately 40% that is produced is lost before it reaches the NWSC's consumers (Whittington et al 2002). Average number of water available days in a week is 4, and even during those 4 days water is available for only 2.4 hrs. One of the major problems with current supply of water is that whatever water is delivered is not clean. Nineteen percentage of the total consumer reported that water is dirty and should be treated before using it. It is found that 7% of household in Kathmandu have to travel for more than 15 minutes to fetch water (CBS-2005). In addition, many households are not connected to the official water supply network. Tens of thousands of Kathmanduites depend on public stand posts, water spouts, privately supplied tankers and bottled water and water supplied by NWSC's tankers to quench their thirst (Whittington et. al 2003).

Inadequacy is not the only problem for water supplies in Kathmandu. Due to intermittent and unreliable water supplies households spend extra money in coping with the intermittent and unreliable water supplies. Kathmanduities engage in several coping strategies to cope with the unreliable water supplies. Some of the major coping strategies are hauling, storing, boiling, and filtering. On the one hand consumers spend significant amount of time fetching and storing water, while on the other significant amount of money is spent for treatment of water. Boiling and filtering are some of the most commonly used methods for treating water.

3. Literature Review

Over the last half century, there has been enormous development of extensive literature in estimating values associated with non marketed goods (Smith et al. 1986 , Ridker et al. 1967, Randall et al. 1974, Bishop et al. 1979 etc). Two types of methods are currently used for the valuation of environmental goods and services; direct and indirect. Since water quality can not be measured through market system, various non market valuation methods have been developed to asses the benefit of water quality (Casey et al 2006, Whittington et al. 2002, Zarah M.H. 2000, Altaf et al. 1993). Both direct as well as indirect methods have been used to estimate the benefit of water quality. CVM is one of the most frequently used methods for the estimation of WTP for household drinking water supplies (Whittington et al. 1990). Using set of scenarios, contingent valuation survey asks how much consumers are willing to pay for the benefits due to improvements in service.

Abdalla et al. (1992) studied the cost of water pollution in Pennsylvania using averting expenditure increase of household to cope for the contamination and concluded that estimate obtained through averting expenditure analysis gives estimates that can be used for the ground water policy decisions. Since then averting expenditure method has also been established as a common method for the estimation of willingness to pay for household drinking water. (Pattanayak et al. 2005, Zarah M. H. 2000, Um et al. 2004, Abrahams et al., 2000). Zarah M. Z. (2000) estimated household demand and willingness to pay for water by assessing the actual behavior adopted by household when they have to cope with an inadequate service in Delhi among 700 households. Using data from a survey of 1500 randomly sampled household in Kathmandu, Pattanayak et al. (2005) concluded that coping cost are almost twice as much as the current monthly bills paid to the water utility but are significantly lower than the estimates of WTP for improved services.

Several studies have also attempted to compare the values obtained from direct methods to that obtained from indirect method (Pattanayak et al. 2005, Um et al. 2004, Abrahams et al. 2000). It is accepted that averting expenditure is lower bound to WTP for environmental quality (Bockstael and McConnell 1999).

Household water supply has been an important policy issue among other policies relating to economic growth of Kathmandu valley. Several studies have been carried out in various aspects of water and its management for Kathmandu valley (Binnie and Partners 1998, Nippon Koe 1999, Silt and DRTC 1999, RTI 1999)[1]. Some studies were conducted to estimate the water consumption and its future projection and other for the estimation of demand and WTP for water.

Current study estimates the cost of coping with unreliable public water supplies and WTP for improved water supplies in Kathmandu valley using the data of Water Survey of Kathmandu-2005, carried out by Central Bureau of Statistics (CBS). Coping costs are calculated from respondents' answer on averting behavior, market price and value of time. WTP for improved water supply is calculated using stated preference method and compared with the value obtained from revealed preference method. Structural consistency across the two models is tested.

4. Theoretical Model for Coping Cost and Willingness to Pay

Economic value of goods or services is measured by change in human wellbeing arising from provision of those goods or services. It is a measure of maximum amount an individual is willing to forgo other goods and services in order to obtain some goods or services. Individual welfare depends not only on quantity of private goods and services, but also on quality. One benefits from non-market goods and services that flow from the resource environment system such as health, visual amenities, and outdoor recreation. Natural resources such as forests and fisheries, environmental system such as clean air and clean water are valuable assets because they yield flows of valuable service to people (Freeman 1993).

[1] As cited in Joshi et al. (2003)

Value of marketed goods and services is determined in the market by explicit exchange between buyers and sellers. However there are varieties of goods and services that are either not traded in the markets or the markets are not complete. For example cleaner air, cleaner water, historical monuments, cultural heritage and public open space are not traded in the market and hence their economic value is not revealed in the market price. Non-market valuation attempts to estimate economic value in dollar terms that a society receives from uses of resources. Contingent Valuation Method (CVM)), Travel Cost Method (TCM), Hedonic Price Method (HPM), Random Utility Method (RUM) and Benefit Transfer Method (BTM) are some of the major tools to estimate value of goods that are not traded in the market.

Water being non-market good, many water quality benefits can not be estimated through the market system and thus non market valuation method is required to estimate the WTP. Two basic approaches have been frequently used for making reliable estimate of WTP for household water use: revealed preference and stated preference approach. The revealed preference method uses data on the observed behavior of water user specially data on averting expenditure. In case of water services WTP consists of current bill as well as investment made to improve quality and quantity of water. In stated preference method individual are asked the maximum amount they are willing to pay for improvement in corresponding service.

Willingness To Pay

According to neoclassical theory, people have preference over goods, both market and non-market. Preference is represented through utility function. The maximum amount that consumers are willing to pay for a good is not same as the amount they actually pay. Difference between the maximum amount an individual is willing to pay and the amount the individual actually pays is consumer surplus, which is the monetary measure of the change in net utility or well being.

Individual derives utility from quantity as well as quality of goods and services. In other words consumer maximizes her utility from quantity and quality of goods and services under her budget constraint. Since consumer wants to stay with the same utility, it is appropriate to use expenditure minimization problem for the optimal demand which gives the same result as given by utility maximization problem. Consumer optimization problem is given by

$$\underset{\{W\}}{Min}\ e(X,W) \quad [4]$$

$$\text{Subject to } U^0 = U(X,W) \quad [5]$$

where X is composite good with unit price and W is water services with price P_W

Above minimization problem can be solved using Lagrange's multiplier to obtain Hicksian demand for the corresponding goods and the Hicksian demand is given by,

$$h_i = h_i(P_W, U^0) \quad [6]$$

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

$$e^* = e(P_W, W, U^0) \quad [7]$$

Where e is minimum expenditure required to achieve fixed level of utility U^0 and using water service W, and is the function of price of other goods, the fixed level of utility and quality of water service itself. Since water service is being offered as take it of leave it proposition, it is a restricted demand problem where consumer does not observe price P_W

and choose W . Instead consumer is offered W and can pay to get it or can leave it. Therefore P_W can be replaced with W (Casey et al. 2006). Then above expenditure function reduces to

$$e^* = e(W, U^0) \quad [7']$$

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

$$\frac{\partial e}{\partial \mathrm{W_i}} = h_i(W, U^0) \quad [8]$$

Since the derivative is change in difference in minimum expenditure required in achieving a change is water services, it is marginal WTP for change in service of W . Marginal value of small increase in W is equal to the reduction in income that is just sufficient to maintain utility at its original level.

$$w_q = -\frac{\partial e(W, U_0)}{\partial W} \quad [9]$$

WTP for the change in quality of water service is the integration of marginal WTP to achieve water service from W_0 to W_1

$$WTP = -\int_{W_0}^{W_1} \frac{\partial e(W, U_0)}{\partial \mathrm{W}} dW \quad [10]$$

$$WTP = e(W_0, U_0) - e(W_1, U_0) \quad [11]$$

This difference in expenditure is either compensating surplus or equivalent surplus. WTP is the difference in expenditure individuals are willing to pay for the change in quality of service to maintain the utility before change or to move to level of utility after change. If the reference level of utility is initial utility, it is compensating and if the reference level of utility is final, it is equivalent surplus.

Coping Cost and Willingness to Pay

Change in welfare due to change in water quality can also be measured indirectly through market for related goods. Individual engage in various averting behavior to cope with unreliable water service. Thus coping strategy appears as logical response to inadequate and unreliable water supply. Averting behavior model suggests that WTP depends on any variable that affect the marginal product of pollution, mitigating activities or avoidance cost (Freeman 1993). Coping cost depends on the averting behavior of consumers. It is based on the assumption that people make choices in order to maximize their wellbeing i.e. utility when faced with the threat of risk. Thus averting expenditure that would be needed to counteract the harmful effect is theoretically correct measure of WTP to avoid the scarcity and decline in water quality. Theoretical explanations of averting expenditure are based on the household production function theory of consumer behavior (Abdalla et al. 1992, Freeman 1993).

According to Courant and Porter (1981), if pollution does not enter into the utility function, averting expenditures are lower bound to WTP. Shortle and Roach (1989) further extended the analysis and demonstrated that averting expenditure are lower bound to compensating variation and equivalent variation even if pollution enters into the utility function. According to Abdalla et al (1992) the estimates obtained through averting expenditure analysis have a sound theoretical basis and are of sufficient magnitude that they can be used for ground water policy decisions. There have been various studies that compared estimates obtained from averting expenditure method with that of the estimates obtained from other non market valuation methods (Abraham et al. 2000, Smith et al. 1986, Carson et al. 1996). Carson et al (1996) carried out an analysis of 83 studies and concluded that mean ratio of contingent valuation to revealed preference method is 0.89 with a 95 percent of confidence interval. Thus averting expenditure provides conservative estimate of benefit of change in water quality.

Suppose household engage in variety of averting behavior to cope with unreliable water service. Consumer's utility depends on market goods, healthy time, averting behavior and water quality.

$$U = U(X, H(A, W)) \qquad [12]$$

Where U is the utility, X is composite market good, H is health production function A is averting behavior and W is water service.

Total expenditure is given by

$$e = X + C(H, P_A, W) \qquad [13]$$

Where $C(H, P_A, W)$ is cost function associated with health production function from drinking water, P_A is averting price.

Consumers' problem is either to maximize utility or minimize expenditure. Here we will follow expenditure minimization problem.

Consumer minimizes expenditure $e = X + C(H, P_A, W)$ subject to initial level of utility

$$U = U(X, H(A, W))$$

The Lagrangian is given by,

$$\Im = X + C(H, P_A, W) + \lambda(U - U(X, H(A, W)) \qquad [14]$$

Above minimization problem can be solved to obtain minimum expenditure necessary to reach utility level U.

$$e^* = e(P_A, W, U) \qquad [15]$$

Change in welfare due to change in water quality is given by compensating variation which is obtained by integrating Hicksian demand curve.

$$CV = e(W_o, U_0) - e(W_1, U_0) \quad [16]$$

Averting expenditure is given by the change in cost associated with original level of health with change in water service,

$$AE = C(H_0, P_A, W_0) - C(H_0, P_A, W_1) \quad [17]$$

Averting expenditure is equal to change in minimum expenditure to achieve initial level of health even after change in quality (Bockstael and McConnell 1999).

$$C(H_0, P_A, Q_0) - C(H_0, P_A, W_1) = e(P_A, W_o, U_0) - e(P_A, W_o, U_0)$$

Now CV can be written as,

$$CV = e(Q_o, U_0) - e(W_1, U_0 : H_0) + e(W_o, U_0; H_0) - e(W_1, U_0)$$

$$CV = AE + e(W_o, U_0; H_0) - e(W_1, U_0) \quad [18]$$

i.e. $$WTP = AE + e(W_o, U_0; H_0) - e(W_1, U_0) \quad [19]$$

The difference of third and forth terms is necessarily greater than zero for improvement in quality. Therefore averting expenditure underestimate the compensating variation for improvement in quality and coping cost is lower bound to the WTP.

5. Results and Discussions

A survey of 2000 household is used for this study. Average number of person per household is 4.6. Almost half of the households live in rented house. Of the total, 16 percent household heads are female. Majority of the household heads (88%) in the study area are literate. Household that have access to telephone are 46 percent and 81 percent of the households have televisions. Out of 2000 household surveyed, about half of the household have private pipe line. 7 percent in urban and 46 percent in rural area does not have any water source in their household premise. Average time taken to fetch water is found to be 4.3 minutes.

Consumption and Demand

Average consumption of water, both directly from tap and other sources are estimated to be 33.19 LPCD. It is higher for the household with pipeline (38.28 LPCD) as compared to the whole sample (27.61 LPCD). Consumers in urban area consume more water (36.91 LPCD) as compared to that of rural (27.61 LPCD). Table 1 describes the distribution of current consumption and demand of water for household use.

Table 1

Consumption and demand of water (LPCD) for household purpose

Household type	Connected			Not Connected		
	Urban	Rural	Total	Urban	Rural	Total
Consumption	39.60	33.68	38.28	24.34	24.31	24.32
Demand	49.72	39.54	47.46	30.77	28.67	29.27

Average demand for water is estimated to be 40.84 LPCD. Demand for water is comparatively high for the household with connected pipeline (47.46 LPCD) as compared to the whole sample (36.91 LPCD). But Average monthly current tariff for water is almost same for household with private pipeline and the whole sample. Demand for water in urban area is comparatively high (46.39 LPCD) as compared to that of rural (32.50 LPCD).

Current Tariff and Willingness to pay

Average WTP is higher for those with private pipeline as compared to whole sample. Current monthly bill is Rs 60.11 per month for the whole sample while consumers are willing to pay Rs 126.11 a month i.e consumers are willing to pay Rs 66 per month as a supplemental charge to obtain a continuous supply of water which is potable and reliable.

Theory suggests that WTP should vary across individual with different socio economic characters. WTP depends on income, wealth, household education level, distance from the existing source etc. (Whittington et al. 1990, Briscoe et al. 1990, Altaf et al. 1993.) In order to analyze the various determinants of willingness to pay a multivariate regression analysis is conducted.

$$WTP_i = \beta_0 + \beta_1(H_i) + \beta_2(D_i) + \beta_3(S_i) + u_i \qquad [20]$$

Where, WTP_i is households' willingness for continuous and potable water supplies, H_i is household characteristics, D_i demographic characteristics, S_i service characteristics, $\beta_0, \beta_1, \beta_2, \beta_3$ are coefficients and u_i is error term. Income, size of the household and education level of the households head are household characteristics. Time taken to fetch water, hours water available during a day are used as service characteristics for above regression. Similarly urban and rural are demographic characteristics of interest.

Many past studies (Gardner and Shick-1964, Primeax and Hollman-1973, Ware and North-1967)[2] have included numerous variables such as per capita value of the homes, lawn area, and number of bathrooms as explanatory variables in lieu or in addition to income. Due to unavailability of per capita household income, weighted value

[2] As cited in Foster and Beatie-1979

of household facilities is included as explanatory variable for income in this study. To capture the effect of type of house ownership, gender, caste, region and type of sanitation, corresponding dummies are added in above model.

[Table 2 about here]

Table 2 summarizes the variables and the regression coefficients for the above model. Two models with and without dummies are estimated. All coefficient of above regression model are as expected. Wealth index and education effects are significant at 1% and 5% respectively. Wealthier and educated households are willing to pay more for water services. Households are willing to pay more if the time required to fetch water is high. Negative sign for coefficient of hours water available during a day is as expected and suggests that people are willing to pay more if water is available for fewer hours a day at the current situation. Negative sign of the household dummy shows that WTP is higher if head of the household is female.

Coping Behavior and Coping Cost

Inadequate and unreliable water supply has made consumer to move towards more reliable alternatives. In order to meet the daily water needs consumers on one hand need to store water while on the other, need to treat water due to unreliability. Nearly 48 percent households have water reservoir tanks in their households. Almost half of the total households in Kathmandu Valley either boil or use filter for purification. Approximately 7 percent of the households in Kathmandu have to travel for more than 15 minutes to fetch water. These data shows that people spend significant amount of money in the form of capital expenditure as a coping cost to avert inadequate and unreliable water supply. Moreover, significant time is lost for the collection of water. Economic cost includes wage losses due to sickness and time spent on fetching water, construction and management of storage system, money spent on treatment especially boiling and filtering. These coping costs provide a lower bound to willingness to pay for additional and reliable water.

Table 3 gives the number of households that engage in different kind of coping strategies. Most of the household connected with pipeline store, boil, and filter while for most of the household which are not connected to the pipe line collection appears as one of their major coping strategy.

Table 3

Different coping strategies by percentage of household

Type of Strategy	Connected			Not Connected		
	Urban	Rural	Total	Urban	Rural	Total
Storage	39.75	8.70	48.00	1.96	4.86	6.80
Collection*	0.00	0.10	.10	7.50	23.65	31.15
Boiling	24.35	3.80	28.15	2.20	3.80	6.00
Filtering	14.05	2.15	16.25	1.00	1.30	2.30

About 48 percent of households have storage tank in their house and incur significant storage cost. Cost of storage tank is calculated from the available market price and amortized for 30 years. Households spend Rs 111 a month for storage tank on average. Members from 625 households spend time collecting water. Cost of collection is calculated on the basis of time spent collecting water. 50 percent of hourly wage rate is used as opportunity cost of time for collection of water. Boiling and/or filtering are two common methods for treatment of water in Kathmandu. Average market price of filter and candle are amortized for 5 years to estimate the cost of filter per month.

Sum of all these costs gives the total monthly coping cost. On average households spend Rs 81.54 to cope with the intermittent and unreliable water supply in Kathmandu. Urban households spend Rs 108.60 whereas rural households spend Rs 41.04 as coping cost. Coping cost for household with connected pipeline and not connected with pipelines are Rs108.43 and Rs28.65 respectively.

In order to get more insight into coping cost and its determinants, a simple multivariate analysis is conducted. Coping strategy can be assumed to depend on income, reliability, education, gender and state of occupation etc. (Zarah M. H. 2000, Abdalla et al. 1992).

$$COP_i = \beta_0 + \beta_1(H_i) + \beta_2(D_i) + \beta_3(S_i) + u_i \qquad [21]$$

Where, COP_i coping cost.

To compare with WTP and to capture the effect of type of house ownership, gender, caste, region and type of sanitation, corresponding dummies are added in above model as in WTP model. Two separate models with and without dummies are estimated and the results are presented in table 4.

[Table 4 about here]

Coefficients of all the variables are as expected and significant. The regression result for coping cost suggests that it is positively related with wealth, education level, and time taken to fetch water. At the same time, people spend more on coping if water is available for fewer hours a day and household doesn't own the house. Urban people spend more on coping cost, particularly because of storage and treatment cost.

Comparison of Coping Costs with Willingness to Pay

Consumers pay in two ways: first, they pay a monthly tariff and the second; they pay indirectly in the form of coping cost. Thus total monthly costs paid for water comprise of monthly bill and total coping cost. Total monthly cost = Fees paid to water supply corporation + (investment in storage facilities +money spent on treatment + monetary value of time spent collecting water + purchasing). Thus total WTP is sum of current fees plus coping costs. Table 5 compares current tariff, coping cost and WTP.

Table 5

Current Tariff, Coping Cost and WTP (Rs) for different households in Kathmandu

Type of cost	Connected			Not Connected			All
	Urban	Rural	Total	Urban	Rural	Total	
Current Tariff	105.17	57.44	94.58	0	0	0	60.11
Coping Cost	126.00	52.91	109.78	26.73	34.57	32.31	81.54
WTP from CVM	181.60	102.01	163.03	69.27	75.97	74.27	126.11
WTP from Coping Cost	231.18	110.35	204.37	26.73	34.57	32.31	141.65

Table 5 shows that households are willing to pay more than the current tariff and is revealed from their coping cost as well as stated in their preference. Households are already paying more than the official tariff through different coping strategies. Households that are connected and are in urban area are paying highest amount as their current tariff and at the same time they are incurring highest amount to cope with the unreliable and intermittent water supply. Household from rural areas that are not connected are willing to pay significantly more than amount spent to cope with unreliable water. Figure 1 illustrates the distribution of household and their current tariff, coping cost and WTP. WTP from CVM and Coping cost is higher than the current tariff for all household i.e. all house hold are ready to pay more than what they are paying currently as their water bill.

[Figure 1 about here]

It is interesting to note from figure 1 that coping cost is not lower bound to the total willingness to pay for whole sample as explained by theory. WTP for the households that are not connected to the official pipeline is greater than their coping cost. But for the households connected to the pipeline coping cost exceeds households' WTP. There can be various reasons associated with this discrepancy. First, one of the significant components of coping cost is storage cost and it is possible that households in Kathmandu invest in storage tank and considers it to be the investment in house instead of investment in water supplies. Second, it can be the case that open ended contingent valuation elicitation of WTP is little less than the actual willingness to pay (Casey et. al. 2006)[3].

Theoretically, WTP and coping cost are related to the same underlying preference for improved water services (Camaron 1992, Pattanayak et al. 2005). Estimates form the regression model for coping cost and contingent valuation model justifies this theoretical statement.

[Table 6 about here]

Table 6 compares expected and estimated sign of coefficients for different household, social and service characteristics and their significance. Based on the

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[3] Casey et. al (2006) estimated willingness to pay for water service using open ended and dichotomous choice method and mean estimation from open ended contingent valuation method is 26% less than that estimated from dichotomous choice contingent valuation method.

estimation of two different models for revealed preference and stated preference we can see from the table 6 that coefficient of most of the variable, except for household ownership dummy, influencing WTP are significant and consistent in sign across two models. Wealth index, education level, time required fetching water and region has consistent positive sign across both models. Similarly number of hours water available during a day, gender dummy have consistent negative sign across both of the models as expected. This consistency in sign suggests that WTP from contingent valuation method and coping cost method are consistently related to same underlying preferences.

6. Conclusion

The existing condition of water supplies in Kathmandu is insufficient to meet the demand for household in Kathmandu. It is not only demand, but consumption as well is significantly low as compared to the other developing cities. We find that consumer faces two folds problem in drinking water supplies. Water supply is not continuous and at the same time, whatever is supplied is not reliable to drink from the tap. To cope with these problems, Kathmanduties engage in several coping strategies: storing, collecting, boiling and filtering. Coping cost is significantly higher than the current bill they are paying to the water supplies authority. Comparative study of WTP from contingent valuation method and coping cost method suggests that WTP and coping cost are conceptually related to same underlying preferences. Unlike previous studies, we find that coping cost is not lower bound to the willingness to pay throughout the sample. Coping cost dominates the willingness to pay for low and high tariff payer, but is lower bound to the willingness to pay for average tariff payer. To conclude, study suggests that households from Kathmandu are willing to pay significantly more to improve efficiency and quality of water supplies service than what they are paying as current tariff and hence water utility levies can be increased to improve the water service. .

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Table 2
Regression result for Willingness to Pay

Variables	Coefficients	
	Model 1	Model 2
CONSTANT	49.12	-25.01
	(10.59)***	(10.86)**
WEALTH	643.52	364.27
	(135.58)***	(98.24)***
EDU	6.64	3.93
	(0.79)***	(0.74)***
TOTAL	6.08	2.28
	(1.42)***	(1.40)*
TIME	-1.15	0.32
	(0.15)***	(0.13)*
HOURS	0.17	-0.83
	(1.11)	(-1.23)
HOWNERSHIP		74.00
		(6.34)***
GENDER		-11.10
		(-7.62)
CASTE		32.86
		(7.71)***
REGION		36.61
		(6.73)***
TFLUSH		98.14
		(12.89)***
CONNECTION		41.51
		(7.72)**
n	1637	1637
R^2	0.1797	0.3436
F	51.01	50.35

Note : ***=.01, **=.05 and *=.10

Table 4
Regression result for Coping Cost

Variables	Coefficients	
	Model 1	Model 2
CONSTANT	35.15	11.95
	(8.24)***	(10.77)***
WEALTH	512.62	313.19
	(69.05)***	(64.86)***
EDU	7.18	4.41
	(0.56)***	(0.63)***
TOTAL	-0.61	1.52
	(1.14)	-(1.15)
TIME	-0.64	0.67
	(0.36)***	(0.35)*
HOURS	-2.27	-5.00
	(0.72)***	(0.88)***
HOWNERSHIP		-18.59
		(6.04)***
GENDER		-19.00
		(8.08)**
CASTE		14.47
		(6.13)**
REGION		14.47
		(5.47)***
TFLUSH		84.82
		(11.11)***
CONNECTION		58.55
		(7.54)***
n	2000	2000
R^2	0.1358	0.2499
F	62.68	61.29

Note : ***=.01, **=.05 and *=.10

Table 6

Expected and estimated sign for Contingent Valuation and Coping Cost Model

Variables	Expected sign	Estimated sign for	
		CVM Model	Coping Cost Model
CONSTANT		+ ***	+ ***
WEALTH	+	+ ***	+ ***
EDU	+	+ **	+ ***
TOTAL	+	+	+
TIME	+	+ **	+ ***
HOURS	-	-	- ***
HOWNERSHIP	+	+ ***	- ***
GENDER	-	-	- **
CASTE	+	+ ***	+ *
REGION	+	+ ***	+ **
TFLUSH	+	+ **	+ ***
CONNECTION	+	+	+ ***

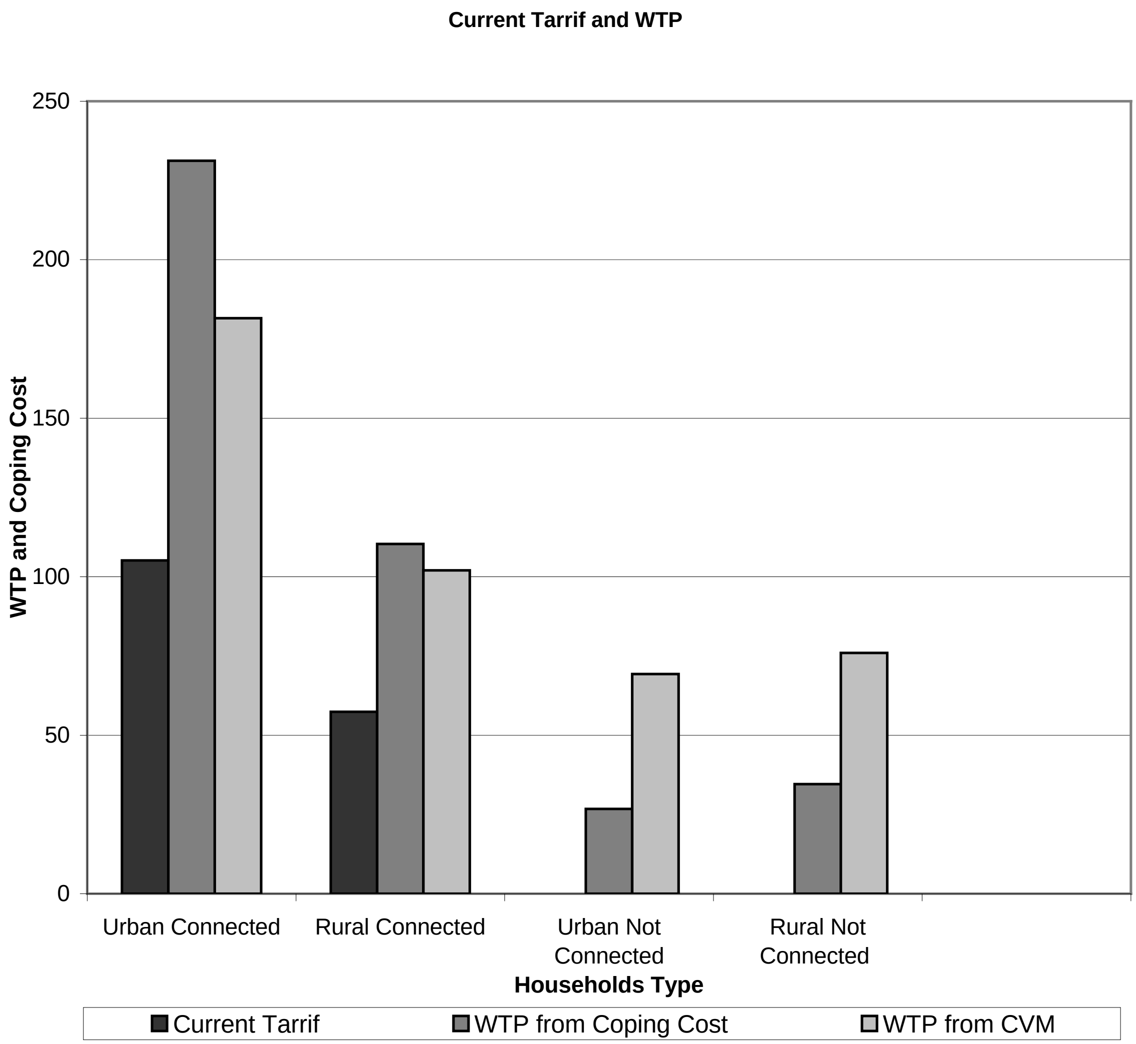
Note : ***=.01, **=.05 and *=.10

Table 8

Descriptive Statistics and Variable Definitions

Variables	Definitions	Mean	Std Dev.
TWTP	Willingness to Pay (Rs)	126.11	135.62
COP	Coping Cost (Rs)	81.54	125.66
WEALTH	Wealth index	0	0.05
EDU	Education level of household head in years	7.85	4.43
TOTAL	Number of household members	4.68	2.22
TIME	Time required to fetch water	5.19	13.47
HOURS	Hours water available per day in minutes	1.63	2.56
HOWNERSHIP	Household ownership (1 = own house; 0 = otherwise)	0.59	0.49
GENDER	Gender of household head (1 = male; 0 = otherwise)	0.84	0.36
CASTE	Caste of the household (1 = Bramhin; 0 = otherwise)	0.23	0.42
REGION	Region (1 = Urban; 0 = otherwise)	0.6	0.49
TFLUSH	Toilet with flush (1 = Toilet with flush; 0 = otherwise)	0.12	0.33
CONNECTION	Connection to the official pipeline (1 = Connected to the official pipe line; 0 = otherwise)	0.63	0.48

Figure 1


Current Tarrif and WTP
250
200
150
100
50
0
WTP and Coping Cost
Urban Connected
Rural Connected
Urban Not Connected
Rural Not Connected
Households Type
Current Tarrif
WTP from Coping Cost
WTP from CVM