Households' Willingness to Pay for Improved Water Services: A Case of Semi-Urban Households in the Lubombo and Lowveld Regions of Swaziland

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Abstract
Management of water resources in an equitable manner by water managers has proved to be a demanding task. Therefore, evaluating domestic water demand behaviours produces an underlying basis for water managers to sustainably and efficiently meet the ever increasing demand for water. Using survey data collected from 314 households in the Lowveld and Lubombo regions of Swaziland, this paper uses the Contingent Valuation Method (CVM) to determine households' willingness to pay (WTP) for improved water services. In estimating the parametric mean WTP and its determinants, the paper uses both the bivariate probit model and univariate probit model, respectively. The results show that 67% of the households were willing to pay the initial bid for improved water services. The mean WTP for a 20 litre of water was estimated at E0.47[1]. Probit model results show that household income, education, gender, distance and owning a backyard garden positively influence household WTP. However, age, water quality and the initial bid offered deter households WTP for improved water services. This suggests that socioeconomic factors should be considered when setting domestic water tariffs and designing strategies for improved water supply services.
Keywords: Willingness to Pay (WTP), Contingent Valuation Method (CVM), Swaziland

1.0 Introduction

The provision of safe and clean water to rural households is one of the commitments of national governments towards the achievement of Millennium Development Goal (MDG) number 7 of reaching out to all people with safe and clean water by 2015. According to Okun (1988), improved access to clean and safe water supply is closely linked to improved economic wellbeing. The clear interdependence between water availability and development is exemplified by the link between water and poverty (Coster & Otufale, 2014). Similarly, the Swaziland Poverty Reduction Strategy and Action Plan (PRSAP) identified the inefficient access to safe and clean water as the core cause of poverty in Swaziland (Government of Swaziland (GoS), 2007). According to the 2013 annual Vulnerability Assessment Committee (VAC) report, it is estimated that about 62% and 64% of the total population have access to improved water sources during dry and rainy seasons, respectively (GoS, 2013).

However, efforts to provide water to people has been undermined by that fact that water resources are under stress due to substantial growth in human populations (International Institute for Environment and Development (IIED), 2012). Rapid population growth has resulted in substantial increases in the demand for water, food and other services. This trend also applies to Swaziland as local water demand is beyond sustainable supply due to increased populations particularly in urban areas (Peter & Nkambule, 2012; Farolfi et al., 2007). Swaziland is divided into four ecological zones: the Highveld, Middleveld, Lowveld and Lubombo Plateau. Due to droughts in recent years, many areas of the country are facing aggravated water scarcity (Mijinyawa & Dlamini, 2008). The dry parts of the Lowveld and Lubombo regions are examples of such areas where water scarcity has inflicted injuries on the social and economic lives of the populace (Mijinyawa & Dlamini, 2008).

Over the years, government has been supplying water to through community taps or boreholes (GoS, 2013). However, these programmes have not been successful mainly because water discharged from these sources are of very low quantities and the sources get desiccated during dry seasons (Mijinyawa & Dlamini, 2008). Moreover, where these sources are relatively reliable, water produced is of compromised quality. These communities rely only on these sources as their main primary source of potable water and the secondary source of buying water from water vendors at high prices further pushes them to a severe poverty trap. To address this

[1] 1 USD = E13.5 Emalangeni

problem, the European Union (EU) through the Government of Swaziland (GoS) and Swaziland Water Service Cooperation (SWSC) has funded a water project to supply communities in these areas, mainly in Matsanjeni, Somnotongo and Siphofaneni, with clean treated water and sanitation services through commercialization of water services. Water will be sold in kiosks for households that cannot afford a private water connection, while those affording, private connection will be made and meters installed for monthly payments.

However, a socially acceptable price to be charged relative to these communities is unknown as this is a project of its first kind in rural communities. The importance of setting a 'socially efficient' price is justified by the fact that an exaggerated price of water can further push households to severe poverty while a very low price can cause unsustainable demand to water, a resource already under stress. However, lack of knowledge on rural household's Willingness to Pay (WTP) for water services exists in the rural areas of Swaziland. This further discourages both government and private interest on establishing more water sources as there is no evidence whether such projects can be successful or sustainable. Moreover, these community water projects put pressure on government expenditures making government unable to expand water supply to other equally poor communities facing aggravated water scarcity. Therefore, as noted by Kanyoka et al. (2008), financially viable rural water projects should come as a form of partial coverage from communities through the introduction of water fees. Therefore, the main purpose of this paper is to estimate WTP for improved water services in the semi-urban areas of the Lubombo and Shiselweni regions, which can potentially improve the understanding of the demand side for improved water services in these areas and thus assists in setting socially acceptable water tariffs and cost recovery purposes.

The rest of the paper is organized as follows: theoretical background of measuring welfare change is presented in section 2. Section 3 presents empirical literature of the CVM. In section 4, Methodology and in section 5, results and discussions are presented. Finally, in section 6 the conclusions and policy implications are summarized accordingly.

2.0 Theoretical Model

The contingency valuation approaches are based upon micro-economic theory of welfare change. Households maximize their utility subject to an income constraint, or minimize their expenditure subject to a given utility constraint (Hanley & Spash, 1993). When evaluating the environmental improvement, in order to be able to derive the corresponding demand function for both the environmental good *w* and market goods *x*, we have to imagine a market situation where the individual actually is able to choose the level of w and x given their prices denoted by p_w *and* p_x, respectively (Hanemann, 1999).

$$\underset{x}{\text{Max}}\, U = U(x, w)\ s.t\ M = p_x x + p_w w \qquad (1)$$

Where U(.) is the utility function which is a subject of *x* the composite of all market goods and *w* the public good quantity. p_x and p_w are the prices of both market goods and the public good (water), respectively, and *M* is household income. Solving the maximization problem we use the Lagrange's Multiplier and is specified as follows.

$$\mathcal{L} = U(x, w) + \lambda(M - p_x x - p_w w) = 0 \qquad (2)$$

Where λ is the Lagrange multiplier. The first order conditions of the langrage can be computed as follows.

$$\frac{\partial \mathcal{L}}{\partial x} = \frac{\partial U(x,w)}{\partial x} - \lambda p_x = 0 \qquad (3)$$

$$\frac{\partial \mathcal{L}}{\partial w} = \frac{\partial U(x,w)}{\partial w} - \lambda p_w = 0 \qquad (4)$$

$$\frac{\partial \mathcal{L}}{\partial \lambda} = M - p_x x - p_w w = 0 \qquad (5)$$

The last condition is simply the constraint. The first two equations were rearranged and divided the first equation by the second equation to get the technical rate of substitution which must equal the price ratio (Varian, 2010).

$$\frac{\partial \mathcal{L}/\partial x}{\partial \mathcal{L}/\partial w} = \frac{\partial U(x,w)/\partial x}{\partial U(x,w)/\partial w} = \frac{p_x}{p_w} \qquad (6)$$

Solving further the utility maximization problem would give the Marshallian demand functions for both market goods and water which are a function of income and the prices for both private goods and water.

$$x^m = d^x(p_x, p_w, M) \qquad (7)$$

and

$$w^m = d^w(p_x, p_w, M) \qquad (8)$$

Substituting the demand function into the given utility function one derives the indirect utility function which forms the underlying basis of welfare change estimation. With the demand functions (5) and (6) derived from the utility maximization process, the indirect utility function $V(p_x, p_w, M)$ that corresponds to the utility function $U(x, w)$ is formed as follows:

$$V(p_x, p_w, M) = U(d^x(p_x, p_w, M), d^w(p_x, p_w, M)) \qquad (9)$$

Therefore, the indirect utility function expresses the maximum utility that can be achieved given prices of both water and market goods, and income. The indirect utility function and the expenditure function provide the theoretical structure for welfare estimation (Haab & McConell, 2002)[1].

In this paper, improved water services was represented by a scenario whereby the household would receive continuous water from a proximate water source, and the water would be of good quality without the need for boiling or any other treatment, however provided at a minimum price of water. Therefore, for this reason, the assumption was that through the water project, a measurable indicator of quality or quantity q, would change from the current status quo (q_o) to a new status (q_1), where $q_o < q_1$. Consequently, the household's utility functions with the quality or quantity indicator changes from $U_0 \equiv v(p_x, p_w, M, q_o)$ to $U_1 \equiv v(p_x, p_w, M, q_1)$. Therefore, in order to measure in monetary terms, the change in utility, the Hicksian measure of CSU is used as shown below

$$V(p_x, p_w, M, q_o) = V(p_x, p_w, M - CSU, q_1) \qquad (10)$$

As the change from q_o to q_1 is a result of the improvement in water services which raises the utility level of a household, to make the household indifferent between the two utility levels, CSU must be positive. In this case, CSU measures the households WTP:

$$V(p_x, p_w, M, q_o) = V(p_x, p_w, M - WTP, q_1) \qquad (11)$$

WTP is the maximum amount of money the household will pay in exchange for the improvement in the water services.

3.0 Review of Empirical Literature

There exists an excess of studies using the CVM method in eliciting the value of water resources for both household and commercial use. Whittington et al. (1990) used the CVM to estimate WTP for water services in Laurent, rural areas of Haiti. The researchers used the bidding game as an elicitation method. They found that respondents are willing to pay U$1.14 per month for improved water. In estimating the value of irrigation water in Homna, a district in Bangladesh, Akter (2007) used the CVM to gather farmers WTP for irrigation water. The study used irrigation charges per decimal of land area per cropping season as the payment vehicle. Results from the study showed that mean WTP was at U$27.83 per season. The study further revealed that the variables age, level of education, household size, number of income sources and ownership of farmland are significantly related to WTP.

In Pakistan, Khan et al. (2010) using the CVM method conducted a study on willingness to pay for water improved quality of drinking water. The study use a sample size of 150 randomly selected households and employed both the multinomial logit and linear regression (OLS) model for households averting behaviours and WTP, respectively. Results from the study revealed that WTP for improved drinking water was significantly determined by income, level of education and households' awareness/exposure to mass media. Banda et al. (2006) also used the CVM to quantify and analyse the relationship between WTP for improved water availability and quality, and the current water availability status in the urban and rural areas of South Africa Steelpoort sub basin. The researchers employed the Tobit model to analyse the factors affecting WTP. Results showed that WTP is affected by monthly water consumption, income, water availability and access to tap water.

In Swaziland, Farolfi et al. (2007) used the CVM to study the determinants of WTP for improved domestic water quality and quantity. A sample size of 343 households was surveyed both in rural and urban areas and a Tobit model to explain household preferences to quality and quantity was used. Results showed that household income, time for water collection, age and gender (female) were significantly and positively associated with WTP for improved quantity. Water consumption and source were also significant, however, with a negative sign. This implies that the more a household consumes water the less the value of WTP for an improvement in quantity. Similarly, households with private water consumption were willing to pay less for more quantities. On improvements in water quality, the study showed that location (rural households), households which practiced avoidance measures, water consumption, household income and current water source were all positively and statistically significant to WTP.

Estimating the economic value of irrigation water in Ethiopia, Mezgebo et al. (2013) used the CVM in eliciting WTP values. The researchers surveyed 154 households in the area and used both the probit and bivariate probit to determine factors affecting WTP decision and mean WTP, respectively. The study used personal interviews and the elicitation format used was both the double bounded dichotomous choice and open ended elicitation formats. Results from the probit model showed that income, age, cultivated land, initial bid, awareness and education level were significantly related to WTP decision. The researchers from the study further concluded that policy should target double bounded elicitation formats than open ended formats as results showed that WTP for the latter was less than that of the former. Ogunniyi et al. (2011) also used a CVM in Kwara state in the western part of Nigeria to analyse the determinants of rural households' WTP for safe water.

[1] One can also consider the dual minimization problem in which expenditures on *x* and *w* are minimized subject to a given utility level.

A survey of 120 households was conducted and a Tobit model was employed to determine the factors affecting households' WTP for improved water quality and quantity. The study found that the age of a household head had a negative and statistically significant influence on WTP. Waiting time and education level were found to be positively associated with a higher WTP. The study also reported that water consumption, household income and water source were significantly related WTP for better water quantity but with a negative sign.

4.0 Methodology

4.1 Empirical *methods*

4.1.1 Estimating Mean Willingness to Pay

This paper uses the dichotomous choice with a follow up question to estimate WTP for an improvement in water services in the study area. The mean is an appropriate welfare measure but not the median (Hanemann & Kanninen, 1999). For the same reason, the paper employs the bivariate probit for double bounded models in estimating mean WTP for improved water services. The econometric model used in a double bounded question starts from equation (12) which simply characterizes a household j's unobserved true willingness to pay.

$$WTP^*_{ij} = \mu_i + \varepsilon_{ij} \quad (12)$$

Where; WTP_{ij} denotes households' j^{th} WTP for improved water services that is unobservable and i=1, 2 represents the respondents response to the first and second questions (bids). μ_1 and μ_2 are basically the means of the first and second bid responses. Proposing that $\mathbf{\mu_{ij} = X'_{ij}}\ \beta_i$ permits both the means to be reliant upon the characteristics of the respondents. The mean WTP is assumed to be the same for all individuals, but potentially varies across question. To construct the likelihood function, the probabilities of observing each of the possible two bid response orders [Yes-Yes, Yes-No, No-Yes and No-No] were derived. The probability that household j answers 'yes' to the initial bid, Y_1, and 'yes' again to the follow up bid, Y_2, is given by;

$$\Pr(yes, yes) = \Pr\left(WTP_{1j} > Y_1, WTP_{2j} \geq Y_2\right)$$
$$= \Pr(\mu_1 + \varepsilon_{1j} > Y_1, \mu_2 + \varepsilon_{2j} \geq Y_2\mu) \quad (13)$$

The probability that respondent j answers yes to the initial bid question and no to the second is given by;

$$\Pr(yes, no) = \Pr\left(WTP_{1j} \geq Y_1, WTP_{2j} < Y_2\right)$$
$$= \Pr(\mu_1 + \varepsilon_{1j} \geq Y_1, \mu_2 + \varepsilon_{2j} < Y_2\mu) \quad (14)$$

The other two response sequences of 'no-yes' and 'no-no' can be constructed analogously. Therefore, following Haab and McConnell (2002), households' j^{th} contribution to the likelihood function is given as;

$$L_j(\mu|Y) = \Pr\left(\mu_1 + \varepsilon_{1j} > Y_1, \mu_2 + \varepsilon_{2j} < Y_2\right)^{YN} * \Pr\left(\mu_1 + \varepsilon_{1j} > Y_1, \mu_2 + \varepsilon_{2j} > Y_2\right)^{YY} * \Pr\left(\mu_1 + \varepsilon_{1j} < Y_1, \mu_2 + \varepsilon_{2j} < Y_2\right)^{NN} * \Pr\left(\mu_1 + \varepsilon_{1j} < Y_1, \mu_2 + \varepsilon_{2j} > Y_2\right)^{NY} \quad (15)$$

Where; YY = 1 for a 'yes-yes' answer, 0 otherwise, NY = 1 for a 'no-yes' answer, 0 otherwise, YN=1 for a 'yes-no' answer and NN=1 for a 'no-no' answer, 0 otherwise. This formulation is referred to as the bivariate discrete choice model. Assuming errors are normally distributed with means 0 and respective variances of σ_1^2 and σ_2^2 and correlation coefficient ρ, then WTP_{1j} and WTP_{2j} have a bivariate normal distribution with means μ_1 and μ_2, and variances σ_1 and σ_2, and correlation coefficient ρ. Given the dichotomous choice responses to each question, the normally distributed model is referred to as the bivariate probit model. Deriving the likelihood function for the bivariate probit model, we use the probability of all four possible response sequences. The probability of a 'yes-yes' response is given as;

$$\Pr\left(\mu_1 + \varepsilon_{1j} > Y_1, \mu_2 + \varepsilon_{2j} \geq Y_2\right) = \Phi_{\varepsilon_1\varepsilon_2}\left(-\frac{Y_1 - \mu_1}{\sigma_1}, -\frac{Y_2 - \mu_2}{\sigma_2}, \rho\right) \quad (16)$$

Where; $\Phi_{\varepsilon_1\varepsilon_2}(.)$ is the standardized bivariate normal cumulative distribution function with zero means, unit variances and correlation coefficient ρ. The probability of a 'yes-no' response is given as;

$$\Pr\left(\mu_1 + \varepsilon_{1j} \geq Y_1, \mu_2 + \varepsilon_{2j} < Y_2\right) = \Phi_{\varepsilon_1\varepsilon_2}\left(-\frac{Y_1 - \mu_1}{\sigma_1}, \frac{Y_2 - \mu_2}{\sigma_2}, \rho\right) \quad (17)$$

The other two probabilities of response sequences can be constructed analogously. Letting y_{1j}= 1 if the response to the first question is 'yes' and 0 otherwise, y_{2j}=1 if the response to the second question is 'yes' and 0 otherwise the resulting likelihood function for a bivariate probit is given below as;

$$L_j(\mu|Y) = \Phi_{\varepsilon_1\varepsilon_2}\left(d_{1j}\left(\frac{Y_1 - \mu_1}{\sigma_1}\right), d_{2j}\left(\frac{Y_2 - \mu_2}{\sigma_2}\right), d_{1j}d_{2j}\rho\right) \quad (18)$$

Where;

$\Phi_{\varepsilon_1\varepsilon_2}(.)$ = standardized bivariate normal cumulative distribution function

d_{1j} = y_{1j} – 1 and d_{2j} = y_{2j} - 1

σ_1 *and* σ_2 = standard deviation of errors

ρ = correlation coefficient

Finally the mean WTP from bivariate probit model will be computed using the formula specified by Haab and

Mconnell (2002) that is,

$$mean\ WTP = -\frac{\alpha}{\beta} \tag{19}$$

Where; α is a coefficient for the constant term, and β is a coefficient for offered bids to respondents.

4.1.2 Determinants of Willingness to Pay

The paper attempts to quantify the relationship between household characteristics and the probability that a household will be willing to pay the initial randomly offered bid value. Given the initial specified amount that have to be subtracted from a given households' income for the proposed improved water services, households have the choice to either accept or decline the pre-specified bid value. Understanding how this decision (WTP) is associated with individual characteristics enhances researchers to gain more information on the validity and reliability of the CVM and to further generalize sample results with the general population (Haab & McConnell, 2002).

The decision of a household to either accept or decline the randomly pre-specified bid can be modeled in a simple random utility framework as shown below (Haab & McConnell, 2002);

$$u_{ij} = u_i(m_j, \boldsymbol{x_j}, \varepsilon_{ij}) \tag{20}$$

Where i=0 for the current status quo and i=1 is the state that prevails when the water project is implemented, the final state. The utility function is a function of m_j, household's j[th] income, x_j, vector of household characteristics and choice attributes, and ε_j, a component of preferences known by the individual respondent but unobserved by the researcher. The basic assumption in this is that through this water project, a measurable attribute is changed. This can be a quality indicator q, changing from q^0 to q^1. Introducing the quality indicator into the utility framework, the current status quo becomes $u_{0j} = u(m_j, \boldsymbol{x_j}, q^0 \varepsilon_{0j})$ and final state becomes $u_{1j} = u(m_j, \boldsymbol{x_j}, q^1 \varepsilon_{1j})$.

As household income is the principal limiting factor for the household, it is thus assumed that a household j[th] will be willing to pay the initial pre-specified bid y_1 given the utility with the proposed project exceeds the current status quo or otherwise reject the bid;

$$u_1(m_j - y_1, \boldsymbol{x_j}, \varepsilon_{1j}) > u_0(m_j, \boldsymbol{x_j}, \varepsilon_{0j}) \tag{21}$$

The probability that a respondent will accept the initial bid is basically the probability that the respondent thinks s/he is better off with the proposed water project than without it, even given the required payment from her/him so that $u_1 > u_0$. The probability function for household j becomes;

$$\Pr(yes_j) = \left(u_1(m_j - y_1, \boldsymbol{x_j}, \varepsilon_{1j}) > u_0(m_j, \boldsymbol{x_j}, \varepsilon_{0j})\right) \tag{22}$$

Given the probability statement above, for parametric estimation, two modelling decisions need to be taken. Firstly, the functional form of the utility function $u(m_j, \boldsymbol{x_j}, \varepsilon_{ij})$ must be chosen. Secondly, an assumption about the distribution of the error term, ε_{ij}, must be made. For the same reason, the utility function can be specified as addictively separable as shown below;

$$u_i(m_j, \boldsymbol{x_j}, \varepsilon_{ij}) = v_i(m_j, \boldsymbol{x_j}) + \varepsilon_{ij} \tag{23}$$

Where $V_i(.)$ is the indirect utility. The probability function equation (22), with the additive specification for the jth household is thus as shown below.

$$\Pr(yes_j) = \Pr[v_1(m_j - y_1, \boldsymbol{x_j}) + \varepsilon_{ij} > v_0(m_j, \boldsymbol{x_j}) + \varepsilon_{0j}] \tag{24}$$

It is, however, worth mentioning that the utility functions are usually unobservable. Given that the deterministic part of the utility function is linear in household income and individual characteristics, the linear utility function can be specified as follows;

$$v_{ij}(m_j) = \boldsymbol{\alpha_i x_j} + \beta_i(m_j) \tag{25}$$

Where m_j is household j[th] s income, $\mathbf{x_j}$ is the m-dimensional vector of household characteristics and $\boldsymbol{\alpha_i}$ is the vector of parameters. The CV scenario induces the respondent to choose between the current water conditions and the proposed conditions of the final state with the required payment *y*. The linear utility function with the CV scenario becomes;

$$v_{1j}(m_j - y_j) = \boldsymbol{\alpha_1 x_j} + \beta_1(m_j - y_j) \tag{26}$$

Where y_j = initial bid presented to the respondent. The utility function of the status quo becomes

$$v_{0j}(m_j) = \boldsymbol{\alpha_0 x_j} + \beta_0 m_j \tag{27}$$

Therefore, the change in utility given by the proposed implementation of the water project can be given by

$$v_{1j} - v_{0j} = (\boldsymbol{\alpha_1} - \boldsymbol{\alpha_0})\boldsymbol{x_j} + \beta_1(m_j - y_j) - \beta_0 m_j \tag{28}$$

The main intuitive of WTP in this scenario is to remove a specified amount *y* from a household income so as to leave a household indifferent between the two scenarios. Thus it is justifiable to assume that income is constant between the two states unless the project provides substantial change. With income constant between the states, $\beta_1 = \beta_0$, and the utility difference becomes;

$$v_{1j} - v_{0j} = \boldsymbol{\alpha x_j} - \beta y_j \tag{29}$$

With the deterministic part of preferences specified, the probability of responding yes becomes

$$\Pr(yes_j) = \Pr(\alpha x_j - \beta y_j + \varepsilon_j > 0) \quad (30)$$

Where $\varepsilon_j \equiv \varepsilon_{1j} - \varepsilon_{0j}$ as the differences between the random terms in the current status and final state cannot be recognized. Assuming that the error terms ε_1 and ε_0 are independently and identically distributed (IID) with zero means gives two commonly used distributions. The probability that the respondent will accept the dichotomous choice question can be estimated as follows;

$$\begin{aligned}\Pr(\alpha x_j - \beta y_j + \varepsilon_j > 0) &= \Pr(-(\boldsymbol{\alpha x_j} - \beta y_j) < \varepsilon_j) \\ &= 1 - \Pr(-(\boldsymbol{\alpha x_j} - \beta y_j) > \varepsilon_j) \quad (31) \\ &= \Pr(\varepsilon_j < \boldsymbol{\alpha x_j} - \beta y_j)\end{aligned}$$

The last inequality represents the symmetric distribution $F(x) = 1 - F(-x)$. This form representation gives us the underlying structural model for estimating the probability of accepting the specified initial bid. The two widely used distributions are the normal and logistic distributions, and are estimated using the probit and logit model, respectively, depending on the assumption on the distribution of the error term (ε) and computational convenience (Greene, 2002). Assuming a normal distribution of the error terms the probit model can be specified. The probit model can thus be specified as latent variable by a structural equation as (Greene, 2002).

$$Y_i^* = \boldsymbol{X'\beta} + \varepsilon_i \quad (32)$$

$$Y_i = \begin{cases} 1 \text{ if } Y_i^* \geq y_1 \\ 0 \text{ if } Y_i^* < y_1 \end{cases}$$

Where;

Y_i^* = the unobserved but true WTP for improved water services.

β = is the vector of parameters

$\boldsymbol{X'}$= is the vector of characteristics or explanatory variables

Y_i = Discrete response of the respondents for the WTP

y_1 = the offered initial bids assigned randomly to the i[th] respondent

ε_i = Unobserved random component distributed as $N(0, \sigma^2)$

4.2 Study Area

The paper used data collected from the semi-urban areas of Shiselweni and Lubombo regions, specifically in Siphofaneni, Somnotongo and Matsanjeni. These areas were chosen due to a current water project which aims at improving water and sanitation services in the areas. The project supports the expansion of an existing network of treated potable water to include an additional 46000 people which is about 7980 households (CSO, 2007). These areas are considered to be in the poorest regions in the country and receive the least rainfalls. Thus, being water stressed areas, community water projects are the main viable source of water for households.

4.3 Data Source and Sampling Procedures

This paper mainly used primary data which were collected from 314 households through a contingent valuation survey using personal interviews. A purposive method of sampling was adopted by selecting the areas mentioned above. This was an appropriate method considering the limitations of the study. Time and money limited the study from including other areas or regions for more investigation. Succeeding the purposive method was a stratified sampling method where chiefdoms in the study areas were used as strata. In each strata, simple random sampling method was employed where households were selected with population proportion to size sampling technique to acquire the desired sample size. This method was chosen because of its merit in ensuring a high degree of representativeness by providing the respondents with equal chances of being selected as part of the sample.

4.4 Survey Design

There are about four main elicitation formats used in any CV survey and these are; Bidding game, Payment card, Open ended and Dichotomous choice method. The paper used the dichotomous choice method with a follow up question where households were asked a sequence of questions which led to WTP. This method was originally developed by Hanemann et al. (1991) and mainly involves questioning respondents two yes or no WTP questions where the bid price in the second or follow-up question is higher (lower) if the answer to first question is positive (negative). The dichotomous choice method with a follow up question is preferred mainly because it has shown to produce more efficient estimates than those from a single question (Hanemann et al., 1991). Haab and McConnell (2002) also found that respondents often gave "protest answers" to open ended questions compared to bounded response questions. Researchers have also appreciated this method in that it helps elicit more information about WTP than the single bound method (Hanemann et al., 1991; Arrow et al., 1993).

Repeated pretesting of the questionnaire was conducted through a pilot survey to about 38 households in the study areas. This was done to minimize any biases which are often associated with contingency valuation surveys. Through the pilot survey, initial bids for the dichotomous double bound model were elicited with the use of open-ended elicitation format. On the pilot survey, households were asked about the maximum amount of money they would be willing to pay for a 20 litre of clean water. From the pilot bids, the randomly assigned bids used were E0.10; E0.20; E0.30; E0.40; E0.50. Pretesting of the questionnaire also helped in redefining the hypothetical scenario to a realistic one and which is in accordance to the needs of the study. The valuation scenario thus tried to provide detailed information about the description of the proposed water project and short and long term benefits with regards to such a project. This all was verbally depicted to respondents in the course of the interview. Furthermore, the use of dichotomous double bounded elicitation enhanced to minimize strategic bias which emanates from respondents trying to influence the price to pay.

The choice of payment mechanism is important in CV studies. The payment vehicle is the mechanism through which the WTP values are to be raised. According to Mitchell and Carson (1989) the payment vehicle should satisfy five conditions and these are; familiarity, credibility, empathy, feasibility and universality. Respondents should be familiar with the payment vehicle which also has to be credible in representing a realistic situation. Empathy of the vehicle entails if the respondent is favorably or unfavorably disposed towards the recipient of the funds. Moreover, the vehicle should be feasible in ways that show the capability of the recipient of funds in delivering the improvement and as well as be universal in that it should affect all respondents or households equally important. It is therefore, for the same reason that the payment vehicle used in the study was to be through a monetary price to be paid for a 20 litre of clean potable water.

5.0 Results and Discussions

5.1 Descriptive Statistics

5.1.1 Socio-Economic Characteristics of Households

Table 1 presents socio-economic characteristics of households. From the sample of 287 households, about 55% were male headed households and 45% were female headed households. Furthermore, 34% were non-married (Divorced and Widowed) headed and 66% were married headed households. Social status of the household heads was also considered for the analysis. From the total households, about 23% reported to be in social positions in their respective communities and the remaining 77% were not. The mean age for the household head was found to be 53.24 years with the maximum and minimum years being 82 and 18, respectively. Results further revealed that the sampled households had a total of 2144 family members. This constituted a mean of 7.47 members per household where the minimum size was 2 members and maximum was 25 members.

The education level of the household head was computed as the number of years spent by the household head in a formal school. Results showed that mean years spent in school by the heads of the sampled households to be at 7.39 years with the minimum and maximum at 0 and 17 years, respectively. Results further revealed the mean monthly household income to be E2322.20 with the minimum and maximum incomes at E100.00 and E7500.00, respectively. Distance to water source was another important variable used in the analysis. On average, mean distance travelled to the main water source was found to be at 783.85 metres (m), with minimum distance at 50m while maximum distance travelled at 3500m. Furthermore, the 287 sampled households reported to be using on average a total of 24550 litres of water per day for household uses. The computed mean for household daily water used and per capita daily consumption for the total households was at 85.54 litres and 13.12, litres respectively.

In addition, households were also questioned about the ownership of a backyard garden. Of the total sampled households, about 49% reported to be having a small garden in their backyard which they water using domestic water. Households were also categorized by their averting behaviour practices. From the total sampled households, only 23% reported to be practicing averting behaviour measures while the other 77% were not. Households in the study area also reported about their perception regarding the quality of water they are currently using. From the total 287 households, about 25% reported water to be ‘very poor’, 40% to be ‘poor’, 16% to be ‘just ok’, 16% to be ‘good’ and 3% reported water to be of ‘very good’ quality.

Table 1. Socioeconomic Characteristics of the Respondents

Variable	Definition	Mean	Std. Dev.	Min	Max
Age	Age of respondents (years)	53.24	12.83	18	82
HHsize	Household size (number)	7.47	3.33	2	25
Income	Monthly Income (Emalangeni)	2325.95	1633.99	100	7500
Distance	Distance Travelled (KM)	0.78	0.50	0.05	3.5
EduLevel	Year of formal education (Years)	7.39	5.01	0	17
HHwaterused	*Households' daily water (litres)*	85.54	29.43	20	200
Gender	Dummy: 1 for male or 0 otherwise	0.55	0.50	0	1
Maritalstatus	Dummy: 1 for married or 0 otherwise (non- married/widowed)	0.66	0.48	0	1
SocialPosition	Dummy: 1 for being in a social position or 0 otherwise	0.23	0.42	0	1
HHGarden	Dummy: 1 for owning a backyard garden and 0 otherwise	0.49	0.50	0	1
AvertingB.	Dummy: 1 for practicing averting behaviors and 0 otherwise	0.23	0.42	0	1
WaterQuality	1='very poor' 2= 'poor' 3= 'just ok' 4= 'good' 5= 'very good'	2.31	1.10	1	5

The paper segregates the respondents into two groups, those willing to pay and those not willing and further investigates whether or not there are differences between these two groups with regard to the socio-economic variables discussed above. Table 2 presents the chi-square test results for frequency difference of discrete variables and Table 3 presents the t-test results for mean difference among continuous variables. The chi-square result shows that the two groups were statistically different with regard to gender, owning a household garden and water quality at 1% probability level. This suggests that households willing to pay are more likely to be male headed, own a household garden and are not satisfied with their current water source. The table further shows statistical differences between the two groups with regard to being in a social position and practicing averting behaviors at 5% probability level.

Table 2. Chi-Square Test for Discrete Variables

Variables	WTP =0		WTP = 1		Total		χ^2
Gender	No.	%	No.	%	No.	%	
Male	41	42.7	117	61.3	158	55.1	8.88***
Female	55	57.3	74	38.7	129	44.9	
Total	96	100	191	100	287	100	
Marital Status							
Married	36	62.5	129	67.5	189	65.9	0.72
Single	60	37.5	62	32.5	98	34.1	
Total	96	100	191	100	287	100	
Social Position							
Yes	13	13.5	52	27.5	65	22.7	6.83**
No	83	86.5	139	72.8	221	77.3	
Total	96	100	191	100	287	100	
Household Garden							
Yes	33	34.4	107	43.9	140	48.8	11.98***
No	63	65.6	84	56.1	147	51.2	
Averting Behaviour							
Yes	14	14.6	52	27.2	66	23.0	5.77**
No	82	85.4	139	72.8	221	77.0	
Total	96	100	191	100	187	100	
Water Quality							
V. Poor	13	13.5	59	30.9	72	25.1	37.17***
Poor	30	31.3	86	45.0	116	40.4	
Just Ok	20	20.8	25	13.1	45	15.7	
Good	31	32.3	15	7.9	46	16.0	
V. Good	2	2.1	6	3.1	8	2.8	
Total	96	100	191	100	287	100	

*Source: Own Survey, 2015. *** & ** Significant at less than 1% and 5% respectively. Non-Willing is a "No" answer for the first bid while willing is a "Yes" answer for the first bid.*

On the continuous variables, the t-test result revealed that the two groups are statistically different with regard to household income, distance travelled, education level and household water used at 1% probability level and with respect to age at 5% probability level. This suggests that households who are willing to pay the initial bid are likely to earn higher incomes, travel longer distances to collect water, received more education and also use more water than their counterparts not willing to pay. This could be attributed to the fact that higher income households are likely to have educated heads who are both capable of paying and are also aware of the importance of using an improved water source. Again, the distance result could be attributed to lack of satisfaction of travelling longer distances as opposed to shorter distances which come with an improved water source.

Table 3. T-Test for Continuous Variables

	WTP = 0		WTP = 1			
Variable	Mean	Std. Error	Mean	Std. Error	t-test	Mean (n=287)
Age (Years)	56.77	1.34	51.48	0.89	3.36**	53.24
HH Size	7.06	0.30	7.67	0.25	-1.48	7.47
Income (E)	1677.99	133.48	2646	122.04	-4.93***	2322.20
Distance (Km)	0.64	0.035	0.85	0.039	-3.49***	0.78
Education (Years)	5.57	0.54	8.31	0.34	-4.51***	7.39
HH Water (L)	77.66	3.20	89.50	1.99	-3.27***	85.54

*Source: Own Survey, 2015. *** & ** Significant at less than 1% and 5% respectively. Non-Willing is a "No" answer for the first bid while willing is a "Yes" answer for the first bid.*

5.1.2 Willingness to Pay

The paper estimates WTP for improved water services in the study areas using a dichotomous choice method with a follow up question. In this method of elicitation, initial bids were randomly distributed to questionnaires. These initial bids were obtained through a pilot survey conducted prior the main survey using open-ended questions. Table 4 presents results from the offered bids from a double bounded dichotomous choice question.

Table 4. Summary of Discrete Response to the Double-Bounded Questions

		First Question		Second Question	
Initial Bid (LowerBid1w)	Follow up Bid (UpperBid2w)	No. of 'Yes' to Initial Bid	No. of 'No' to Initial Bid	No. of 'Yes' to follow up Bid	No. of 'No' to follow up Bid
E0.10	E0.20	19	0	18	1
E0.10	E0.05	0	0	0	0
E0.20	E0.40	53	0	30	23
E0.20	E0.10	0	21	20	1
E0.30	E0.60	58	0	26	32
E0.30	E0.15	0	22	14	8
E0.40	E0.80	48	0	9	39
E0.40	E0.20	0	41	32	9
E0.50	E1.00	13	0	1	12
E0.50	E0.25	0	12	9	3

Source:

From the initial bids, follow up bids were then calculated to be half the initial bid given a 'no' response to the first question and double the initial bid given a 'yes' response to the initial bid. Therefore, for a single bid offered to a respondent, there are two possible responses. From Table 4, the first row for each initial bid summarizes the 'yes' responses and the second row summarizes the 'no' responses to that bid. This therefore means each randomly assigned bid is summarized in two rows as per the nature of double bounded questions. The initial bid of E0.1 resulted in 19 'yes' responses and zero 'no' response. Of the 'yes' responses to Bid1w=E0.1, the follow up question, Bid2w=E0.2, resulted to 18 'yes' responses and 1 'no' response. Similarly, the second initial bid E0.2, resulted to 53 'yes' responses and 21 'no' responses. Of the 'yes' responses to Bid1w=E0.2, the follow up question, Bid2w=E0.4, gave out 30 'yes' responses and 23 'no' responses. Again on the 21 'no' responses for Bid1w=E0.2, the follow up question Bid2w=E0.1 resulted to 20 'yes' responses and 1 'no' response. The third bid of E0.30 had 58 'yes' responses and 22 'no' responses. From the 58 'yes' responses, the follow up Bid2w=E0.6, resulted to 26 'yes' responses and 32 'no' responses. Of the 22 'no' responses to the third initial bid (Bid1w=E0.3), the follow up question with Bid2w=E0.15 gave out 14 'yes' responses and 8 'no' responses. The other fourth and fifth initial bids, Bid1w=E0.4 and Bid1w=E0.5, can be interpreted similarly as shown above in Table 4.

5.2 Estimation of mean WTP

Using the dichotomous double bounded format, the parametric mean WTP was estimated for both the lower and the upper bids. The paper used the seemingly unrelated bivariate probit (SUBP) model as specified by Haab and McConnel (2002) and results are presented in Table 4. As per the nature of double bounded formats, households were randomly offered an initial bid and depending on the response to the first bid, a follow up (double or half the initial bid) bid was offered. Preliminary results showed that the 'yes' responses from the first bid and second were about 67% and 55%, respectively. Moreover, the mean of the initial bid offered was found to be at E0.31 while for the follow up bid, mean was at E0.45 cents.

Table 5. Estimates of the Bivariate Probit Model

Variable	Coefficient	Std. Error	z-value	p-value
LowerBid1w	-3.002927	0.7460074	-4.03	0.000***
Constant	1.380597	0.2523819	5.47	0.000***
UpperBid2w	-3.251243	0.5607972	-5.80	0.000***
Constant	1.585703	0.2543797	6.23	0.000***
Athrho	0.2456473	0.2257557	1.09	0.277
Rho (ρ)	0.2408227	0.2126629		
Log likelihood = -333.0551				
Number of Observations = 287				
Wald chi2(2) = 47.32				
Prob > chi2 = 0.0000				
Likelihood-ratio test of rho=0	chi2(1) = 1.28435		Prob > chi2 = 0.2571	

Source: *** Significant at less than 1

The result revealed that both the initial bid (LoweBid1w) and the follow bid (UpperBid2) to be statistically significant at less than 1% probability with negative signs. The result therefore indicates that the higher the initial and follow up bid, the less the probability of that bid being accepted. The result is consistent with economic theory of demand for environmental and natural goods. As it can be seen from the table, 'rho' (ρ), which measures the correlation of the residuals of the two models, is 0.24 which is not close to one, thus is not statistically significant at any level. This implies that the error term of WTP for the first question is not perfectly correlated with the error term of WTP for the second question (bid). Using these coefficients in Table 4.2, the mean willingness to pay for improved water services from the double bounded elicitation format was calculated using the formula proposed by Habb and McConnell (2002) (see equation 19). The result showed that mean WTP for the initial and follow up bid to be E0.45 and E0.49, respectively. This meant that households in the study area can pay up to E0.47 for a 20 litre of water.

5.3 Determinants of Willingness to Pay

In this section, the paper assesses the determinants of willingness to pay, which is, willingness to pay the pre-specified initial bid presented for improved water services in the study area. A probit model was used in the analysis where the dependent variable (WTP) was binary taking values of 1 for 'willing' and 0 for 'not willing'. Other variables were included in the model as independent variables. This included both dummy and continuous variables which were households' socio-economic variables, perceptions and other practices related to water use. Results for the probit model are given in Table 6.

Table 6. Probit and Marginal Effect Results for Willingness to Pay

Variable	Coefficient	Std Error	Z-value	Marginal Effects	Z-value
Age	-0.0164**	0.0071295	-2.29	-0.0055**	2.30
Gender	0.5274 ***	0.1818199	2.90	0.1768***	2.91
S. Position	0.3013	0.2272916	1.33	0.0957	1.41
EduLevel	0.0379**	0.0182473	2.08	0.0127**	2.08
HHIncome	0.0002***	0.0000621	2.82	0.0001***	2.82
Waterused	0.0045	0.003195	1.40	0.0015	1.40
WaterQuality	-0.2311***	0.0831678	-2.78	-0.0775***	-2.77
AvertingB.	0.3126	0.2258062	1.38	0.0991	1.48
Distance	0.6451**	0.2273038	2.84	0.2162***	2.91
HHgarden	0.5640***	0.1818845	3.10	0.1866***	3.19
LowerBid1w	-2.2356**	0.8612673	-2.60	-0.7494**	-2.59
Constant	-0.1244	0.6865627	-0.18		

Log likelihood = -130.70425
Number of observations = 287
LR chi2(11) = 104.41
Prob > Chi2 = 0.0000
Pseudo R2 = 0.2854

*** & ** Significant at less than 1% and 5% respectively.

From Table 5, the age of the household head (Age) is significant and negatively associated with WTP for improved water services at less than 5% probability level. This basically implies that, holding all other variables constant at their means, a one year increase in the age of the household head reduces the probability of accepting the initial bid by 0.55%. This result was not in line with the findings of Farolfi et al. (2007) but consistent with the findings of Ogunniyi et al. (2011) and *apriori* expectations. Gender of the household head also showed to be significantly related to WTP however with a positive sign. The results showed that male headed were more willing to pay for improved water services than their female counterparts. Keeping other variables constant at their mean values, being male increases the probability of accepting the initial bid by 17.7%. This result however was not consistent with *apriori* expectations. This is because since it's the women who carry the burden of water collection in most rural households, it was expected that they will be more willing to pay than males. However, the result may be so because in Swaziland, males are regarded to be the heads hence responsibilities or decisions of making any payments rely upon them, other than females. This result again was not in consonance with the findings of Farolfi et al. (2007).

The number of years the household head attended school (EduLevel) proved to be consistent with *apriori* expectations as the variable took a positive sign and was significant at less than 5% probability level. This result implied that, keeping other factors constant at their mean values, a one year increase in the education level of the household head increases the probability of WTP by 1.3%. This can be mainly because more educated household heads are more aware with the importance of clean water utilization hence are more willing to pay for an improvement in such a service. The result was true with the findings of Kanayo et al. (2013); Ogunniyi et al. (2011) and Akter, (2007). Average monthly income (HHIncome) was another strong factor of WTP. This was shown by the positive coefficient and statistical significance at less than 1% probability level. This again, meant that, keeping the influences of other factors constant at their mean values, a one lilangeni increase in household income increases the probability of accepting the first bid in by about 0.001%. Generally, this implies that an increase in income of a household shifts the demand curve for clean and potable water to the right. This result was in-line with the *apriori* expectations of the study and economic theory as higher income families have better chances of maximizing utility and enjoy better and high quality goods. The result was also true with the findings of Khan et al., (2010); Farolfi et al. (2007); Ogunniyi et al. (2011) and Kanayo et al. (2013).

The quality of water (WaterQuality) also proved to be influencing WTP. The variable had a negative sign and statistically significant p-value at 1% probability level. Keeping all other factors constant at their mean values, a unit increase in the quality of water as perceived by households, lowers the probability of saying 'yes' by 7.8%. This result was in line with *apriori* expectations as it is rational human behaviour that households using safe water may be satisfied and thus not willing to pay more for a similar good. Similarly, the initial bid offered (LowerBidw) to households had a negative sign and statistical significance as economic theory predicts. The bid was found to be significantly associated with WTP at 1% probability level. This implied that, holding other factors at their mean values, an E0.10 increase in the bid offered to households decreases the probability of accepting it by 74.85%.

The variable distance to water source (Distance) showed that the further the distance travelled, the higher the disutility to the household involved. The result was significant at 1% probability level with an *apriori* positive sign. This thus implies that households who travel long distances to fetch water are more likely to be willing pay for an improved and nearer water source as compared to their counterparts. Holding all other factors constant at their mean values, a one kilometre increase in the average distance travelled by households increases the probability of WTP by 21.62%. The result was also in line with the findings of Kanayo et al. (2013). Ownership of a small garden in a household (HHGarden) was also another influencing factor to WTP. The variable was significant and with a positive sign, suggesting that households owning gardens in their backyard were more willing to pay than their counterparts. This meant that a household owning a garden has a higher probability of accepting the initial bid by 18.67%, *ceteris paribus*. The result was true to the *apriori* expectations of the study as household gardens are one vital form of enhancing both food security and nutrition levels in households. Therefore, households owing gardens are aware of that and would appreciate a closer source of water to enhance their production.The variables averting behavior (AvertingB.), social position (S.Position) and water consumption (Waterused) were not significant factors of WTP, however they all had a positive sign.

6.0 Conclusions and Policy Recommendations

The paper used a stated preference approach in an effort to assess the demand side for domestic water services in the Lubombo and Lowveld regions of Swaziland. Households' WTP shows that there is room for policies or projects aimed at improving rural domestic water using a water price system that can be used for cost recovery, sustainability and demand management purposes. This is important particularly because of the change in water demand management from a supply oriented approach to a demand oriented approach for water demand management in these areas. Households showed that they are capable of paying an amount of up to E0.47 for a 20 litre of clean potable water. The implication of this is that partial recovery on investment costs and operating costs required for sustainability of the project can be achieved through the introduction of water tariffs.

Empirical results showed that socio-economic factors such as gender, household size, household income, education, distance, water quality and others are responsible for both households WTP decision. It is, therefore, important for policy and water managers to address the water problem in these areas having taken into consideration these important characteristics affecting water demand. Therefore, the study findings concluded that WTP for improved water and water demand depends on both consumers' and product sensory attributes.

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