Journal of Economics and Sustainable Development www.iiste.org
ISSN 2222-1700 (Paper) ISSN 2222-2855 (Online)
Vol.3, No.14, 2012

# Willingness to Pay for Improved Rural Water Supply in Goro-Gutu District of Eastern Ethiopia: *An Application of Contingent Valuation*

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**Abstract**

This study employs a contingent valuation method to estimate willingness to pay for improved rural water supply. It provides information on the demand for improved services and the potential for them to be sustainable. The analysis was based on data collected from 132 households using rural water utilities for at least three years. Both binary and ordered probit models were used to examine the determinants of willingness to pay. The estimated mean and median willingness to pay was found to be Birr 6.83 and 5.87 per household per month. Results indicate that households using water purification methods earn better annual income, participated during the early phase of project implementation and are spending more time in collecting water and hence are more likely to pay. Whereas those households with large family members, which use reliable water sources from convenient water points and got higher starting bid values are less likely to pay. This implies the need to take the specific characteristics of rural households and their service level demand into account in planning rural water supply projects, which may contribute to set sound cost recovery system that can sustain the service delivery.

**Key Words**: Cost-recovery; Valuation; Water supply; Willingness to pay

## 1. *Introduction*

Access to safe water is a fundamental human need and a basic human right. Upholding the human right to water is an end in itself and a means for giving substance to the wider rights in the Universal Declaration of Human Rights and other legally binding instruments. These rights include the right to life, education, health and adequate housing. Ensuring that every person has access to at least 20 liters of clean water each day to meet basic needs is a minimum requirement for respecting the right to water and a minimum target for governments. Deprivation of clean water costs 1.8 million child deaths each year. For instance, as a result of Diarrhea, there are about 4,900 deaths globally each day, loss of 443 million school days each year from water-related illness. Moreover, women and children spend hours a day collecting water with high opportunity cost of time that would have been spent in education or employment (Mengesha *et al*., 2002; UNDP, 2006b). This will lead to water insecurity especially for those households with higher demand due to large family size (Collick, 2008).

Described as the water tower of Africa, Ethiopia has abundant water resources, including 12 river basins and 22 natural and artificial lakes. It is estimated that per capita renewable fresh water resources total 1,924 $m^3$ per year. The exact groundwater potential of the country is unknown, but it has been estimated to be approximately 2.6 billion $m^3$ (ADF, 2005). Despite this, many Ethiopians have been suffering from lack of access to safe drinking water for centuries. The majority of drinking water sources in rural Ethiopia are still rivers, streams, hand-dug wells, and intermittent springs, none of which are protected from flooding or livestock, wildlife, and human contamination.

Despite the fact that the Ministry of Water Resources (MoWR) along with the support of many international and local organizations is actively involved at the grassroots level to improve the situation, clean water supply coverage is still very low in many parts of the country, particularly in rural areas, where 84% of the population lives (ADF, 2005). One of the bottlenecks for the government is lack of financial requirements for the development of water supply projects. Biswas (2005) indicated that development of rural water supply schemes remains too costly for poor countries relative to their available resources. The millennium development goal's

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need assessment for Ethiopia estimates that the financial requirements for halving the proportion of population without sustainable access to safe drinking water in 2015, is 23.2 Billion Birr out of which 3.4 Billion should be secured from consumers, 3.7 Billion from the government and 16.1 Billion from external partners (UNDP, 2006a). The situation is getting worse when the existing water supply systems are getting out of service early after construction. The failure of many water sources developed through large scale projects or investments is the worst case scenario. One out of four rural water facilities are broken down or poorly functioning in developing countries and the construction of new systems cannot even keep pace with the failure of the old ones in some countries (Kleemeier, 2000).

While only 39.4% of the populations of Ethiopia have access to safe drinking water, one of the lowest coverage levels worldwide (UNDP, 2006a), absence of lack of any policy framework to coordinate water resource development and provision of potable water supply have exacerbated the problem. Nevertheless, Ethiopian government formulated the country's water resource management policy in 1999 to alleviate the problem of access to safe water supply and achieve rapid socioeconomic development. The water supply and sanitation policy is an integral part of the county's water management policy. The policy document underlines the need to improve the financial bases needed for water development projects cost recovery. One strategy is to ensure that all water supply interventions will adequately address costs associated with operation and maintenance and be based on "cost-recovery" principles. The implementation of the country's water supply policy to accelerate the universal access program focuses on the demand side. That is, in order to implement the existing policy for the improved water supply in the rural areas, the price mechanism and regulatory environment need to receive the necessary attention (MoWR, 2001). As pricing of water is the key component of an appropriate incentive for efficiency, sustainability and accountability (Varela-Ortega *et al*., 1998), there is a need to examine the demand for the service and willingness to contribute to service costs. Such evidence helps understand the fundamental value that consumers place on the improved rural water service. In such a process a price that reflects households' willingness to pay for improved water supply services can be established. The objective of this paper is to identify factors that affect rural households' willingness to pay for potable water supply.

## 2. Literature Review

### *2.1 Environmental valuation*

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 can benefit from non-market goods and services that flow from the environment and natural resources. Natural resources such as forests, fisheries and clean water and environmental and ecosystem services such as clean air, visual amenities, and outdoor recreation are valuable because they yield flows of services to people (Freeman, 1993).

The challenge remains putting monetary values on environmental goods and services as they do not have easily observed market prices. These prices are presumed to be a means to ration resources to those who value them the most. Individuals are swept along by Adam Smith's invisible hand to achieve what in theory is best for society as collective optimal private decisions based on mutually advantageous exchange which leads to optimal social outcomes (Hanley *et al*., 1997). However, for environmental assets markets can fail if prices do not communicate society's desires where prices often understate the full value of services provided by an asset or do not exist to send a signal to the marketplace about the value of the asset (Hanley and Spash, 1993). Market failure occurs when private decisions based on these prices, or lack of them, does not generate an efficient allocation of resources.

There are two main arguments for putting a price on environmental goods such as clean water, air quality, biodiversity and natural environments. First, we need to know the marginal value of environmental goods to find the socially "right" (optimal) quantity and quality of different environmental goods. Second, if environmental goods are not valued explicitly, they will still be valued implicitly through policy decisions (Navrud, 1992). Non-market valuation attempts to estimate economic value in monetary terms that a society receives from uses of resources (Kolstad, 2000). Economists have developed a variety of techniques to value non-market environmental and cultural amenities consistent with the valuation of market goods either using revealed preference methods (production function, travel cost, hedonic pricing, simulated markets and market prices) or stated preference methods (contingent ranking, choice experiment and contingent valuation) (Navrud, 2000; Hanley and Spash, 1993; Graton *et al.*, 2004)).

The hedonic pricing method of environmental valuation uses surrogate markets for placing a value on environmental quality as in the case of real estate market. It associates the levels of environmental services with the prices of the marketed goods like houses. The travel cost method places a value on non-market environmental goods by using consumption behavior in related markets such as using services of environmental assets as a proxy for price including travel costs, entry fees, on-site expenditures and outlay on capital equipment necessary for consumption (Grafton et al., 2004). The contingent valuation method, which was used first in the early 1960s when economist Robert K. Davis used questionnaires to estimate the benefits of outdoor recreation in a Maine backwoods area, has been widely employed as it circumvents the absence of markets for environmental goods by presenting consumers with hypothetical markets in which they have the opportunity to buy the good in question. Since the elicited willingness to pay values are contingent upon the particular hypothetical market described to the respondent, this approach came to be called the contingent valuation method (Mitchell and Carson, 1989).

The contingent valuation method has some inherent limitations including inconsistency with rational choice, implausibility of responses, absence of a meaningful budget constraint, and information provision and acceptance extent of the market (Arrow *et al*, 1993). Despite this, it is argued that studies employing this method in environmental research have witnessed robust progress. In particular, with advances in the use of econometric analysis, survey research methods, sampling and experimental design, it enabled better understanding of consumer preferences and policy applications in the last 50 years (Smith, 2006).

### 2.1. Empirical Evidence

The willingness to pay (WTP) survey for safe drinking water has been conducted in many places in developing counties. Kaliba *et al.* (2002) conducted an analysis to estimate WTP to improve community-based rural water utilities in the Dodoma and Singida Regions of Central Tanzania. Adebusola and Bolarin (2009) have studied WTP for improved water supply in Osogbo Metropolis, Nigeria using a binary logit model and found that income determines willingness to pay for improved water supply. Komatsu *et al*. (2007) conducted a WTP study for rural water supply improvements for pastureland conservation in Mongolia and found that distance from the water points, education, herders' perception of pastureland degradation, income and initial bid value significantly determine their WTP for improved water supply. Monarcho and Gudas (2009) conducted a study on contingent valuation approach to estimate the benefits of water quality improvement in the Baltic States. Using a payment card, they indicate that connection to the sewerage network, being active user, living near a water point and income influence households' desire to contribute to the better water quality.

A study on citizen's willingness to pay for improved and sustainable water supply in a medium-sized city of South Western Nigeria shows that main source of domestic water used, access to improved source, distance from main source, average time spent to fetch, adequacy of supply, amount of water purchased and attack by water borne diseases determine willingness to pay (Olajuyigbe and Fasakin, 2010). A few of the studies undertaken in Ethiopia emphasized the urban water supply. Genanew (1999) indicates that income, education, sex of the respondents and water available at the time of the survey determine willingness to pay. Alebel (2003) conducted an affordability and willingness to pay survey and found that gender, income, monthly expenditure for water consumption, quality and time taken to fetch from the existing sources are important determinants. The affordability analysis indicates that consumers are able to pay if they are provided with the improved water supply service at a price equal to the average incremental cost of providing the improved water supply. Similarly, a set of contingent valuation studies reveals a number of factors: age, household size, volume of water consumed, reliability of the existing water supply, bid value and monthly income (Gossaye, 2007); price per bucket of vendor water, water purification practice, monthly income and wealth of the respondent (Kinfe, 2008); income, education level, reliability on the existing water supply and perception of service quality (Simret, 2009).

## 3. *Methodology*

### 3.1. Survey design and data collection

Field data were collected from three rural *kebeles* of Goro-gutu district that participated in community water supply projects for a period of three years prior to the field surveys. Purposive sampling followed by random sampling procedures was employed to select 132 respondents. First, from 28 rural *kebeles* (9 highlands, 9 midlands and 10 lowlands), three rural *kebeles*; Chafe-Anani (highland), Kobo-Welteha (midland), and Bika (lowland) were purposively selected. These *kebeles* were selected based on agro-climatic zones and the availability of at least two improved water supply projects which had served the communities for at least three years. Then, the water supply projects found in each of the selected *kebele* was identified. From 11 listed water supply projects found in the three *kebeles* a total of six projects were purposively selected (two from each selected *kebeles*) based on the service period of at least three years prior to the time of the survey. Lastly, a listing of beneficiaries for each selected project was obtained and 132 sample households were randomly selected using probability proportion to sample size.

Two survey instruments were developed to gather the necessary information (*i.e*., checklist and structured questionnaire). The checklist solicited general information at the water supply project level. This was done for each water supply project through group discussions attended by *district* water resources development (WRD) office staffs, rural *kebele* leaders, development agents, and water committee members. The major objective of the checklist was to get a general overview of the existing water supply situations and to design the hypothetical market scenario. The discussion helped to initially characterize the existing water supply situations of the project and was used to develop the hypothetical market scenario and to come up with first draft of the questionnaire. In order to identify the initial bid values, open ended question was used in the draft contingent valuation questionnaire to solicit ranges of respondent's willingness to pay for improved water supply services at the three water sites.

Pre-test of the draft contingent valuation questionnaire was made with 18 households who were randomly selected from the three types of water supply schemes (spring on spot, spring development and hand pump). The pretest helped to get further information to choose payment vehicle, identify initial bid values, further designing sound hypothetical market scenario for the improvement of the existing water supply projects and adjust the pre-coded responses. The district WRD office charge a tariff (*i.e*., specific amount per liter of water used) for engine driven water pumps as it has high operational (fuel) and maintenance costs and charges a user-fee (*i.e.,* specific amount per month per household) for non-motorized schemes. Out of the 76 constructed water supply schemes found in the district, only 4 are motorized schemes while the other 72 are non-motorized schemes. The payment vehicle is chosen to be monthly user-fee since the selected 5 water supply schemes for this study are non-motorized in their type and represent the vast majority of schemes found in the district.

The starting bid values were obtained from the pre-test conducted with open ended WTP question. In the pre-test six households from the spring on spot water supply project users were willing to pay 1, 2, 3, 3, 4 and 5 Birr per household per month. So, the average 3 Birr is selected as one starting bid value and its upper limit/premium and the lower limit/discount values identified are 4.5 and 1 Birr, respectively. While six households from spring development water supply project users were willing to pay 3, 5, 5, 5, 6, and 6 Birr per household per month. Hence, the average 5 Birr is selected as a second initial bid value and its upper limit and the lower limit values identified are 8 and 2 Birr, respectively. The remaining six out of the 18 pre-tested households from hand pump water supply project users were willing to pay 5, 5, 7, 8, 10, and 13 Birr per household per month. Therefore, the average 7 Birr is selected as a third initial bid value and its upper limit and the lower limit values identified are 10 and 5 Birr, respectively. The identification of the upper and lower limit for each identified initial bid values were made within the limit of the response to the WTP question. The survey questionnaire included sections which describes the scenario to the respondents followed by questions related to WTP for improved rural water supply service in Ethiopian Birr (ETB[12]). The respondents were randomly assigned a set of three bid values from a list of three given in Table 1. The first bid value in each set is the starting WTP amount. In the follow up question, the respondents are offered a second bid value which is greater than the first one if the answer to the first question is "yes". If the answer to the first question is "no", the second bid value will be lowered to the value presented in the bid set.

**Table 1**

### *3.2. Empirical methods and estimation procedures*

Water being non-market good, many water quality benefits cannot be estimated through the market system and thus non market valuation method is required to estimate the WTP (Thamapapillai, 2002). To capture individual preferences between the current and the anticipated new water system and determine factors influencing his/her preferences, a discrete econometric model has been used. This approach works with the utility function in that the utility derived from using new improved water services may be expressed as a function of several attributes such as characteristics of the current source and socioeconomic characteristics of the family. Thus, what is needed is a model that describes the probability that a particular household will choose to use a new water source.

[12] 1US$ = 13. 56 ETB (December, 2009)

In this approach, first it is assumed that a household chooses between two sources based on maximizing two conditional indirect utility functions, the first of which describes the utility gained from using the new source, and the second the utility derived from use of the current water source. The probability that a family will decide to use the new rather than the current source is higher when the probability that the conditional indirect utility function for the new sources is greater than the conditional indirect utility function for the current source.

The contingent valuation method is frequently applied to discrete survey responses to elicit options on various matters. The respondent households were initially asked whether or not they would be willing to pay a specific amount for improved rural water supply service. When a respondent is asked one dichotomous choice question, the response is usually "Yes" or "No", depending on the individual's willingness to pay the proposed bid value. It is assumed that respondents know which choice maximizes their utility. The common starting point for analyzing such alternatives is the random utility model (Lee and Mjele, 2007). The utility that individual *i* will chose an alternative *j* can be expressed as:

$$U_{ij} = V_{IJ} + e_{ij} \tag{1}$$

Where $U_{ij}$ and $V_{ij}$ represent the indirect and deterministic utility individual *i* receives on choosing alternative *j* respectively and $e_i$ is random component of utility function. The random component is assumed to be identically, independently distributed with zero means. The marginal utility of payment depends on an expected improvement in water quality or quantity.

In this approach, first it is assumed that a household chooses between two sources based on maximizing two conditional indirect utility functions, the first of which describes the utility gained from using the improved water service (*k*), and the second the utility derived from use of the current water service (*j*). Let $P_i$ be a specific amount that a respondent is willing to pay to get the improved water service k. An individual will choose alternative *k* over alternative *j* if utility from *k* is greater than from *j* (Hanemann, 1984). That is,

$$U_{ik}((Y - P_j)/x_i) > U_{ij}(Y/x_i) \tag{2}$$

Where *Y is* income and $X_i$ represents a vector of socio-economic characteristics of individual *i.* An individual will be willing to pay an amount of $P_i$, if the utility gained from the situation with improved water service is larger than the utility with the current water supply service taking into account the change in income. Assuming $U_{ik}$ takes a linear form, the change in utility according to Haab and McConnel (2003) can be expressed as:

$$\Delta U_i = U_{ik} - U_{ij} = \alpha_i + \beta_1 (Y - P_j)/x_i - \alpha_0 - \beta_0 Y/x_i > 0 \tag{3}$$

The probit model in this study is used to calculate mean willingness to pay for the closed-ended format. According to Hanemann *et al.* (1991), one of the main objectives of estimating an empirical WTP model based on the contingent valuation survey responses is to derive a central value (or mean) of the WTP distribution. As Gunatilake *et al*. (2006) illustrate, econometric modeling allows undertaking a number of validity tests that adds credibility to the WTP estimates. Also the closed-ended format information provides direct answers to questions related to demand for improved water supply and sanitation. These additional uses help design suitable tariff/user-fee and pro-poor water supply and sanitation services, estimate revenues of the water utility, and provide answers to basic questions on effective demand in water supply and sanitation project designs. The truncated mean WTP value is calculated employing the following equation (Hanemann *et al*., 1991):

$$E(WTP) = ln(1 + e^{\beta 0} / \beta_1) \tag{4}$$

That is, first the intercept and slope of bid will be estimated by regressing dependent variable ("yes" or "no" response) on initial bid value, other explanatory variables held constant. Then, these estimated coefficients will be replaced in equation (4) above to calculate the mean WTP value. Since each respondent was subjected to double bounded contingent valuation questions in which the respondent was presented with two bids, the level of the second bid is contingent up on the response to the first bid.

Accordingly, the respondents are asked if they would pay the initial bid value. If the initial bid ($B_i$) is accepted, a premium will be asked ($B_u$); while if the initial offer is rejected, a discount will be offered ($B_d$). Answers to the two sequential questions can be sorted into four intervals: [0, $B_d$] when the first and second answers are "no"; [$B_d$, $B_i$] when a discount offer is accepted at the second bid; [$B_i$, $B_u$] when the premium is rejected, and [$B_u$,Z] when both answers are "yes" and Z denotes income of the respondent. Since respondents' WTP is a latent variable and not subject to direct observation, the sequential questions serve to place upper and lower bounds of the true WTP. Hence, the responses can be ordered into the following indices for WTP: Y = 0 if WTP < $B_d$ $\Rightarrow$ the response is "no-no"; Y = 1 if $B_d$ < or = WTP < $B_i$ $\Rightarrow$ the response is "no-yes" Y = 2 if $B_i$ < or = WTP < $B_u$ $\Rightarrow$ the response is "yes-no", and Y = 3 if WTP > $B_u$ $\Rightarrow$ the response is "yes-yes".

Thus, an ordered probit model is used to estimate the model. The ordered probit model involves a qualitative dependent variable for which the categories have a natural order or ranking that reflects the magnitude of some underlying continuous variable or index. This model is based on the following specification:

$$\begin{gathered} y_i^* = X'\beta + \varepsilon_i \quad where \quad \varepsilon_i \sim N(0,1) \\ y_i = 0 \quad if \ y_i^* \le \varphi_0 \\ y_i = 1, \quad if \ \varphi_0 < y_i^* \le \varphi_1 \\ \ldots \\ j \quad if \ y_i^* > \varphi_{J-1} \end{gathered} \tag{5}$$

Where $y^*$ is an unobservable index and $x$ is a vector of independent variables. The observed counterpart to $y^*$ is $y$. The $\varphi$'s are unknown 'threshold' parameters that are estimated along with the other parameters in the model. In this study, $j$ is equal to 3. Then the probabilities of observing $y$, given $x$ can be expressed as:

$$\begin{gathered} Prob(y = o) = \Phi(-X'\beta) \\ Prob(y = 1) = \Phi(\varphi_1 - X'\beta) - \Phi(-X'\beta) \\ Prob(y = 2) = \Phi(\varphi_2 - X'\beta) - \Phi(\varphi_1 - X'\beta) \\ Prob(y = 3) = 1 - \Phi(\varphi_2 - X'\beta) \end{gathered} \tag{6}$$

Where $\Phi$ (.) is the standard normal cumulative distribution function such that the sum of probabilities is equal to 1.

## 4. Results and Discussions

### *4.1. Descriptive results*

The code, definitions and descriptive statistics of important variables are presented in Table 2. They include respondents' socio-demographic characteristics (gender, age, education, and family size), economic conditions (household total annual income and ownership of livestock), and discrete and dummy variables for and respondents' perception of existing water supply service situations (reliability, number of family members affected by water born diseases, number of alternative water sources, participation during the early phase of project implementation and household level purification method used). The survey result revealed that the respondents were predominantly female (97.3%) with an average age of 32.46 years. The average family size of the total sample households is 5.86, and it ranges from 1 to 12. The education level of the respondents ranges from a minimum of not able to read and write to the maximum of grade 9. The average number of family members who attended formal education is 2.63, and it ranges from a minimum of 0 to a maximum of 8.

In rural communities of Ethiopia, where agriculture remains to be the basic source of livelihoods, access to agricultural land and the number of livestock a household owns not only reflect its status in the society but also its command over income and other livelihood diversification options. The average land holding size and livestock of the total sample households were 0.44 hectares and 2.21 TLU, respectively. The average annual income of the sample households was 8,695 Birr, and it ranges from low income of 870 Birr to high income of

36,564 Birr. The majority of the sample households (62%) were involved in non-farm and/or off–farm income generating activities in addition to the on-farm activities while the rest 38% only depend on on-farm activities. Average dependency ratio[13] for the sample households is 1.11, and it ranges from 0 to 4.50.

**Table 2**

The results reveal that the majority 116 (87.8%) of the respondents reported that they were not satisfied with the existing water supply services while the remaining 16 (12.2%) were satisfied. The average time taken to fetch water for sample households was almost 3 hours and 25 minutes with average waiting time of 2 hours and 29 minutes and the average single trip (from home to the water point) time of half an hour. From the total sample households, 93% of the respondents reported that women and girls are responsible for collecting water, of which the majorities (65%) of them carry it on their back while the rest (35%) use donkeys.

Almost 68.9% of the respondents perceived a sense of responsibility to protect and maintain the public water supply systems while 31.1% believed this is the responsibility of the government and Water, Sanitation and Hygiene Committees. Concerning responses to experience of paying user fee or tariff for water, almost 47% said they have never paid while 53% paid at least once for the service. Out of the total sample respondents, 61% reported that the locations of the water points were inconvenient in terms of distance and topography while 39% said that they were convenient. The results also reveal that only 30% of the total sample respondents have taken part in community participation during the construction of the water supply projects through providing labor, local materials, or hospitality costs (*i.e*., food, tea, accommodation or coffee for those who are constructing the water scheme) while the rest have not. Out of the total sample households 30.3 % reported that at least one of their family members had experienced water-borne disease during the year 2009.

**Table 3**

It is also important to examine whether or not those who are willing to pay the initial bid value are different from those who are not willing to pay with regard to the above socio-demographic and economic variables as well as existing water supply situations. Table 3 presents the t-test results for mean difference of continuous variables and Table 4 presents the chi-square test results for frequency difference of discrete variables. The t-test result reveals that the two groups are statistically different with regard to the initial bid value assigned to respondents at 1% probability level and with respect to household size at 10% probability level. More specifically, those households who are willing to pay were offered higher starting bid values than those households who are not willing to pay *i.e.,* the starting bid value has created a starting point bias which is expected from the contingent valuation study. Households who are willing to pay are also characterized by having fewer family members compared with those households who are not willing to pay. This could be due to the reason that fewer family members mean greater shortage of labor to fetch water from distant places where old water points are located.

**Table 4**

Indeed, the two groups may not only differ in terms of continuous variables, but also in terms of discrete variables. In this respect, a chi-square test was used to examine the existence of statistically significant differences between the two groups. Accordingly, 6 discrete variables were considered and the two groups were found to be different in terms of 3 variables (Table 4). The chi-square test result for frequency difference shows that the two groups are statistically different with regard to reliability of the existing water supply services at 1 percent probability level and educational level of the respondent at 10 percent probability level. This means that households who are willing to pay are more likely to have attended formal education and are more likely to be reliant on unreliable water supply services. The two groups also statistically differ with regard to participation of the household during the early phase of project implementation at 5 percent probability level. This may be because those households who have contributed during the early phase of the project implementation are more willing to pay for the improved water supply service than those who do not participate.

### *4.2. Determinants of Willingness to Pay*

The first analysis was done with the simple discrete choice model to explain whether a respondent is willing to pay for improved rural water supply service over the existing water supply service. The sample household is

[13] The dependency ratio of the household was calculated as the number of individuals aged < 15 years and > 65 years per productive individual 15-65.

either willing or not willing to pay the initial bid value offer for improved rural water supply service. Accordingly, the variable willing to pay for improved rural water supply was used as a binary dependent variable taking a value 1 indicating the respondent's willingness to pay for the service and 0 otherwise. Accordingly, a binary probit model was estimated using the 14 identified explanatory variables (Table 5).

**Table 5**

Among the 14 explanatory variables included in the analysis, 8 variables were found to have significant impact on respondents' willingness to pay for improved rural water supply service at 1%, 5% and 10% probability level respectively. Reliability of the existing water supply service (RELIAB), household size (HHSIZE) and initial bid value offered to respondents (IBV) are significant at 1% probability level. The coefficients of total household income per year (INCOME), time taken to fetch water (TIME) and convenience of the location of the water point (CONLOC) are found to be significant at 5% probability level. While the coefficient estimates of household participation during the early phase of project implementation (PARTIC) and use of household level water purification practice (PURIF) have a significant impact on WTP at 10% probability level.

**Table 6**

The findings indicate that the policy of supplying free water to any group, except in emergency, limits sustainable supply of services. As there is no sufficient fund to provide such free services, the rural poor are the first to suffer from interruption of services. A better and much more equitable way would be to collect water charges from consumers and then improve and expand the system. The results imply that the Ethiopian government can improve potable water supply service for rural area with tariff structures set based on the objective of recovering operation and maintenance costs. Cost recovery program has the advantage of providing incentive for proper use; reduce waste and excessive consumption of water resources. Besides, it helps secure funds for expanding and improving rural water supply projects in many parts of the country to achieve the Millennium Development Goal.

Such strategies have been effective elsewhere as witnessed by a number of case studies. These studies uncover that deterioration of water quality and irreversible damage to the available water resources are resulting from poor or non-participation of consumers in sharing the costs of maintaining the water supply infrastructure. They further indicate that when there are no well-defined, transparent and traded water rights based on contributions made, water use institutions may encourage higher use rather than conservation of water (Varela-Ortega, 1998; Ahmad, 2000). In this study, the importance of participation becomes unquestionable as those households which participated in any type of scheme are more likely willing to pay than others (Table 4).

The formulation and implementation of cost recovery policy needs to give attention to the specific socio-economic conditions (income, service reliability, resource endowments and access to technologies to purify water). Program for water supply and sanitation within the framework of an integrated approach to water resource management is the other essential aspect in promoting efforts towards attaining full coverage of the service. In the long-term, the issue of subsidy for cost recovery could be down–played if consumption is demand- driven and property rights are specified. This would enable customers to show their demand through their willingness to pay for different levels of service. It is anticipated that positive willingness to pay indicates potential community ability to recover operation and management costs (Altaf *et al*., 1992). Such values provide crucial information for assessing economic viability of projects, setting affordable tariffs (user-fee), evaluating policy alternatives, assessing financial sustainability, as well as designing socially equitable subsidies (Berg *et al*., 2006). That is substantial reduction in service costs is possible only if effective cost recovery is achieved and consumers mobilize additional funds (Cairncross, 1990).

A precondition for this is to design improved rural water supply projects in such a way that they encourage users' financial contributions and involvement in decision making (Prokopy, 2005). Technology choice must follow a more holistic and pragmatic approach in such a way that it does not involve high "recurrent costs" (Mcneill, 2002) as income determines consumers' willingness to pay. Results of this case imply that purification costs can be reduced through encouraging users' to share costs of maintaining improved water supply scheme in the district (Tables 4 and 5).

## 5. Conclusions

The result of this study is consistent with the empirical literature in that annual income determines willingness to contribute to the maintenance of improved water supply scheme in the district. But there is inconsistency in its effect when an income increases indicating that as long as capital constraint limits a household's willingness to contribute, the intervention scheme should opt for a simple and affordable technologies requiring low maintenance cost. Although participation in the early phase of the project implementation favors willingness, the weak post- construction management of the pre-existing schemes to undertake minor and major maintenance implies that property rights to improved water supply scheme were not clearly defined – a major problem evident in many countries (Ahmad, 2000 ) and underlined in collective action studies (Beyene, 2009). An important lesson from this is that the proposed rural water supply development projects in the district (or elsewhere in Ethiopia) need to ensure property rights prior to persuading contribution to maintenance of the scheme. Eventually, dissatisfaction with the existing water services due to unreliability and inconvenience indicates the inherent great potential to secure users' participation in maintenance through introducing water user-fees so that the proposed improved water supply service will be delivered.

**Acknowledgement**

We would like to acknowledge RiPPLE (Research-inspired Policy and Practice Learning in Ethiopia and the Nile Region) program for the financial support to undertake this research and for this our deepest gratitude goes to Dr. Alan Nicol, former RiPPLE Country Director and Dr Eva Ludi, former RiPPLE Research Director, for their unreserved and all round support in financing and professional comments on the research. We are also grateful for the respondents for their kind cooperation and valuable time.

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**Annex**

Tables

**Table 1: Frequency distribution of bid-value sets and bid responses of CV questionnaire**

| Bid value set; First bid (Second bids) | Total | (no, no) N | (no, no) % | (no, yes) N | (no, yes) % | (yes, no) N | (yes, no) % | (yes, yes) N | (yes, yes) % |
|---|---|---|---|---|---|---|---|---|---|
| 3 (4.5, 1) | 45 | 2 | 4.44 | 10 | 22.22 | 14 | 31.11 | 19 | 42.22 |
| 5 (8, 2) | 42 | 2 | 4.76 | 14 | 33.33 | 13 | 30.95 | 13 | 30.95 |
| 7 (10, 5) | 45 | 15 | 33.33 | 13 | 28.89 | 10 | 22.22 | 7 | 15.56 |
| Over all | 132 | 19 | 14.4 | 37 | 28.0 | 37 | 28.0 | 39 | 29.6 |

*Source*: Household survey, 2010

**Table 2: Code and definitions of explanatory variables**

| Code | Definition | Mean N=132 | Std. Dev. |
|---|---|---|---|
| PURIF | Dummy: 1 if the household takes any kind of water treatment like boiling, medicine, and/or filtering ; 0 otherwise | 0.58 | 0.496 |
| NALTWS | Number of alternative water source the household use | 1.83 | 0.999 |
| NUFMAF | Number of family members affected by water born diseases | 0.36 | 0.609 |
| RELIABg | Dummy: 1 if the respondent ranks the reliability as good; 0 otherwise | 0.37 | 0.484 |
| RELIABa | Dummy: 1 if the respondent ranks the reliability as average; 0 otherwise | 0.29 | 0.454 |
| RELIABp | Dummy: 1 if the respondent ranks the reliability as poor; 0 otherwise | 0.34 | 0.475 |
| SEX | Dummy: 1 if the respondent is male; 0 if female | 0.97 | 0.172 |
| EDUC | Dummy: 1 if the respondent attended any level of formal education; 0 otherwise | 0.25 | 0.435 |
| AGE | Age of the respondents (years) | 32.17 | 10.213 |
| HHSIZE | Household size (number) | 5.86 | 2.129 |
| TIME | Time taken to fetch water (hours) | 3.23 | 1.695 |
| PARTIC | Dummy: 1 if the respondent participated in any type (money, labor or hospitality costs) during the early phase of project implementation; 0 otherwise | 0.30 | 0.461 |
| CONLOC | Dummy: 1 if the respondent founds the location convenient; 0 otherwise | 0.39 | 0.490 |
| INCOME | Annual household income (Birr) | 8695.81 | 5332.92 |
| IBV | Initial bid value (Birr) | 5.0 | 1.658 |
| LIVEST | Livestock holding (TLU) | 2.21 | 1.72 |

*Source*: Household survey, 2010

**Table 3: T-test for continuous variables**

| Variables | WTP = 0 (N=56) | | WTP = 1 (N=76) | | t-test for Equality of Means | |
|---|---|---|---|---|---|---|
| | Mean | Std. Dev. | Mean | Std. Dev. | t-value | Sig. |
| AGE | 33.09 | 10.11 | 31.49 | 10.3 | 0.890 | 0.374 |
| HHSIZE | 6.29 | 2.12 | 5.55 | 2.09 | 1.977* | 0.050 |
| TIME | 3.34 | 1.77 | 3.18 | 1.64 | 0.515 | 0.607 |
| NALTWS | 1.70 | 1.06 | 1.92 | 0.95 | -1.279 | 0.203 |
| NUFMAF | 0.27 | 0.48 | 0.43 | 0.68 | -1.560 | 0.121 |
| IBV | 5.57 | 1.61 | 4.57 | 1.58 | 3.547*** | 0.001 |
| INCOME | 8614.25 | 5142.29 | 9224.86 | 5488.47 | -0.648 | 0.517 |
| LIVEST | 2.07 | 1.52 | 2.31 | 1.85 | -0.813 | 0.418 |

*** and * are significant at 1% and 10% probability level, respectively.

*Source*: Household survey, 2010

**Table 4: Chi-squared test for discrete variables**

| Discrete variables | | Non-willing | | Willing | | Total | | Chi-square |
|---|---|---|---|---|---|---|---|---|
| | | No | % | No | % | No | % | |
| RELIABg | No | 21 | 37.5 | 62 | 81.6 | 83 | 62.9 | 26.839*** |
| | Yes | 35 | 62.5 | 14 | 18.4 | 49 | 37.1 | |
| RELIABa | No | 51 | 91.1 | 43 | 56.8 | 94 | 71.2 | 18.172*** |
| | Yes | 5 | 8.9 | 33 | 43.4 | 38 | 28.8 | |
| RELIABp | No | 40 | 71.4 | 47 | 61.8 | 87 | 65.9 | 1.319 |
| | Yes | 16 | 28.6 | 29 | 38.2 | 45 | 34.1 | |
| EDUC | Illiterate | 46 | 82.1 | 53 | 69.7 | 99 | 75.0 | |
| | Literate | 10 | 17.9 | 23 | 30.3 | 33 | 25.0 | 2.647* |
| SEX | Male | 2 | 3.6 | 2 | 2.6 | 4 | 3.0 | |
| | Female | 54 | 96.4 | 74 | 97.4 | 128 | 97.0 | 0.097 |
| PURIF | No | 26 | 46.4 | 30 | 39.5 | 56 | 42.4 | |
| | Yes | 30 | 53.6 | 46 | 60.5 | 76 | 57.6 | 0.638 |
| PARTIC | Not-participated | 44 | 78.6 | 48 | 63.2 | 92 | 69.7 | |
| | Participated | 12 | 21.4 | 28 | 36.8 | 40 | 30.3 | 3.627** |
| CONLOC | Inconvenient | 36 | 64.3 | 44 | 57.9 | 80 | 60.6 | |
| | Convenient | 20 | 35.7 | 32 | 42.1 | 52 | 39.4 | 0.552 |

***, ** and * are significant at 1%, 5% and 10% probability level, respectively.

*Source*: Household survey, 2010

Table 5: Parameter estimates and marginal effects of binary probit model

| *Explanatory Variables* | *Coef.* | *Robust Std. Err.* | *Marginal Effects* | *P-value* |
|---|---|---|---|---|
| PURIF | 0.70884** | 0.29437 | 0.26329 | 0.016 |
| RELIABa | 2.02117*** | 0.40475 | 0.54592 | 0.000 |
| RELIABp | 1.17351*** | 0.41762 | 0.38386 | 0.005 |
| NUFMAF | 0.32371 | 0.23103 | 0.12019 | 0.161 |
| TIME | 0.25481** | 0.10361 | 0.09462 | 0.014 |
| NUALTWS | 0.10203 | 0.13353 | 0.03788 | 0.445 |
| PARTIC | 0.63600* | 0.35373 | 0.22067 | 0.072 |
| CONLOC | -0.84397** | 0.39157 | -0.31432 | 0.031 |
| EDUC | 0.26110 | 0.32662 | 0.09417 | 0.412 |
| SEX | -0.48201 | 0.79412 | -0.15913 | 0.480 |
| AGE | -0.00499 | 0.01678 | -0.00185 | 0.766 |
| HHSIZE | -0.21836*** | 0.07824 | -0.08108 | 0.005 |
| INCOME | 0.00007** | 0.00003 | 0.00003 | 0.020 |
| LIVEST | 0.15028 | 0.09919 | 0.05580 | 0.130 |
| IBV | -0. 65778*** | 0.11970 | -0. 24424 | 0.000 |
| Constant | 1.80534 | 1.26108 | | 0.152 |

Log pseudolikelihood = -53.289541
Wald chi2(15) = 69.16
Prob > chi2 = 0.0000
Pseudo R2 = 0.4077

***, ** and * are significant at 1%, 5% and 10% probability level, respectively.

*Source*: Household survey, 2010

Table 6: Parameter estimates and marginal effects of ordered probit model

| *Explanatory variables* | *Coef.* | *Robust Std Err* | *P>z* | *Marginal Effects* | | | |
|---|---|---|---|---|---|---|---|
| | | | | Y=0 | Y=1 | Y=2 | Y=3 |
| PURIF | 0.55632** | 0.22573 | 0.014 | -0.06023 | -0.15547 | 0.06685 | 0.14884 |
| RELIABa | 1.32563*** | 0.27803 | 0.000 | -0.09433 | -0.37437 | 0.01298 | 0.42868 |
| RELIABp | 1.04895*** | 0.29865 | 0.000 | -0.08558 | -0.28786 | 0.04981 | 0.32364 |
| NUFMAF | 0.29891 | 0.18612 | 0.108 | -0.02957 | -0.08679 | 0.03317 | 0.08319 |
| TIME | 0.21989*** | 0.07793 | 0.005 | -0.02175 | -0.06384 | 0.02440 | 0.06119 |
| NUALTWS | 0.08092 | 0.10093 | 0.423 | -0.00800 | -0.02349 | 0.01141 | 0.02252 |
| PARTIC | 0.27778 | 0.22812 | 0.223 | -0.02519 | -0.08115 | 0.02557 | 0.08076 |
| CONLOC | -0.69371** | 0.28140 | 0.014 | 0.07973 | 0.18872 | -0.08817 | -0.18031 |
| EDUC | 0.03478 | 0.26461 | 0.895 | -0.00339 | -0.01012 | 0.00376 | 0.00975 |
| SEX | 0.11550 | 0.82989 | 0.889 | -0.01043 | -0.03390 | 0.01073 | 0.03360 |
| AGE | -0.02103** | 0.01048 | 0.045 | 0.00208 | 0.00611 | -0.00233 | -0.00585 |
| HHSIZE | -0.06328 | 0.05301 | 0.233 | 0.00626 | 0.01837 | -0.00702 | -0.01761 |
| INCOME | 0.00008*** | 0.00003 | 0.001 | $-8.56e^{-06}$ | -0.00002 | $9.6e^{-06}$ | 0.00002 |
| LIVEST | 0.02508 | 0.07088 | 0.723 | -0.00248 | -0.00814 | 0.00278 | 0.00698 |
| BIDSET3 | -2.57108*** | 0.38851 | 0.000 | 0.50435 | 0.28919 | -0.28794 | -0.50561 |
| BIDSET2 | -0.65753** | 0.27594 | 0.017 | 0.08080 | 0.17557 | -.09243 | -0.16394 |
| /cut1 | -1.34037 | 0.93887 | | | | | |
| /cut2 | 0.01073 | 0.94577 | | | | | |
| /cut3 | 1.01584 | 0.94718 | | | | | |

Log pseudo likelihood = -133.56954
Wald $chi^2$ (15) = 105.70
Prob > $chi^2$ = 0.0000
Peseudo $R^2$ = 0.2517
***, ** and * are significant at 1%, 5% and 10% probability level, respectively.
*Source*: Household survey, 2010