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Willingness to pay for watershed protection by domestic water users in Gondar town, Ethiopia

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Abstract
Payment for Environmental Services is a way to address environmental degradation problems in which those who benefit from the environmental services pay to those who provide these services, which they fail to realize due to public good nature of the services. So, using the contingent valuation survey method, this study established the WTP of domestic water users in Gondar town for improved watershed protection using 245 randomly selected households. Most respondents have given positive WTP response for watershed protection so as to generate solutions to environmental problems associated with Angereb watershed, which would help them to ensure the provision of improved domestic water supply. To analyze factors affecting household's decision to involve in watershed protection or not Probit and Tobit econometric models were used. The results of Probit model showed that variables education level of the respondent, income of the household, level of satisfaction with the existing water service and awareness of the respondent about watershed benefits influences positively respondents probability of WTP for watershed protection while household size and initial bid value influences negatively. The Tobit model results depicted that WTP amount is positively related to level of education of the respondent, income of the household, level of satisfaction of the respondent, awareness of the respondent and initial bid value offered.

Keywords: Angereb watershed, Contingent valuation method, Determinants of willingness to pay, Economic valuation, Payment for improved watershed protection, Willingness to pay

1. Introduction

Surface waters such as lakes, rivers, wetlands, and ground water provide many diverse goods and services to human society. Hence, the issues of water availability, access and quality are of fundamental importance to development, poverty reduction and ecosystem sustainability (Hartwick and Olewiler, 1998 [17]; Aylward, *et al.,* 2010) [2]. The quality and quantity of water available to water users from a given watershed depends on the distribution of vegetation, the underlying geology and the way watershed resources are used and managed within the watershed (Gete, 2010) [9].

Ethiopian highlands are not only sources of livelihood from agriculture but they also provide watershed services such as sources of fresh water to millions of people. However, increased pressure on land use of the highlands has resulted in watershed degradation in the highlands (ibid). Remedial actions have been proposed to tackle the problems of degradation on agricultural lands; to tackle problems of siltation of lakes and reservoirs downstream; and to guarantee stable water regime in streams.However, most of physical and biological works of soil and water conservation have been ineffective due to lack of community participation, poor land management practices, and lack of effective planning and implementation approaches for resource management (Yohannes and Herweg, 2000 [30]; Carlsson, *et al.,* 2005 [6]; Bewket, 2007 [3]; Gete, 2010) [9].

Failure to balance resource management interventions with the level of resource degradation and socio-economic status of the resource user is a growing challenge to resource users to meet both immediate economic objectives and sustainable environment (Yohannes and Herweg, 2000 [30]; Gete, 2010) [9]. Unless they realize the benefit, resource users have little reason to account for the negative externality of their land use decisions. So, designing an integrated watershed development plan considering the interests of service beneficiaries of the watershed as part of a sustainable solution to the burden of water supply reservoir sedimentation, Pollution etc is important (Kerr, *et al.,* 2006 [19]; Gete, 2010) [9].

As watershed is a vital source of potable water supply and helps to control siltation of water supply reservoirs, people attach positive economic values to watershed services (Pagiola, *et al.,* 2004) [22]. However, lack of markets for these watershed services implies lack of information for policy makers and resource managers, which makes difficult efficient watershed management decisions and mechanisms. Hence, according to Chandler and Suyanto (2005) [7] failure to consider watershed services in resource use and management decision results in degradation of the resources. Policy makers have designed a market based mechanism, Payment for Environmental Services (PES), to address the problem of market failure on some uses of environmental resources. According to Wunder (2005) [29] PES is a voluntary transaction where an environmental service beneficiary pays to service provider for an environmental management practice that secures the required environmental service.

Agenda 21 of the UNCED (1992) [26] and the FDRE/MoWRs (2001) [8] Ethiopian water sector policy recognizes that water supply is an integral part of the overall water resources management and incorporate water supply planning in comprehensive water resources management undertakings as water resource is scarce natural resource with an economic value. And it ensures and promotes that fees should be paid for services rendered by watershed resource to efficiently and sustainably manage the watershed resource based on willingness to pay of the service beneficiary.

Angereb watershed is a vital watershed to the residents of Gondar town as it feeds into the Angereb reservoir and boreholes found in Angereb valley from where residents obtain their potable water. However, Angereb watershed is one of the high sediment yielding catchment and with intermittent water flow (SCI, 1999 [23]; FDRE/ANRS/GTWSSS, 2011) [10]. Substantial sediment and insufficient water production are attributable to poor watershed resource management practices (Bewketu, 2009) [4].

To implement watershed management schemes efficiently and sustainably, collaboration of various stakeholders such as watershed service users is required (Kerr, *et al.,* 2006) [19]. So, proper pricing of watershed services in Ethiopia in general and the study area in particular is important so that domestic water users are involving by paying the proper amount of money for the services of the watershed which ensures the sustainability of improved potable water supply provision. Therefore, assessing domestic water user's valuation of an improved Angereb watershed protection and factors affecting their willingness to pay (WTP) for watershed protection is of great importance to provide the necessary economic information to develop socially acceptable, environmentally sound and financially feasible watershed management program.

2. Methodology

2.1 Description of the Study Area

The study has been conducted in Gondar town which is located in the northwestern part of Ethiopia, in Amhara regional state, at a distance of 737 km from Addis Ababa, the national capital. Gondar is a capital town of North Gondar Zone Administration. According to the most recent population census of CSA (2007), which was compiled and reported in May, 2010, the population of Gondar town is 207,044.

All the inhabitants of Gondar town get potable water from the water supply service distributed by GTWSSS for their domestic purposes from different mode of services (FDRE/ANRS/GTWSSS,2011) [10]. The current water supply sources of Gondar town are Angereb River (the related Angereb reservoir), and eight boreholes located in Angereb watershed.

2.2 Sampling Design and Sample Size

The target sample households were selected using a two-stage simple random sampling technique. A total of 245 households were selected randomly from selected kebeles using proportional to size sampling technique. The study used a method developed by Green (1991) to select the total sample size from the total households. Green (1991) suggested a rule-of-thumb that $N \geq 50 + 8m$, where N is minimum number of sample households required to conduct multiple regression analysis and m is the number of explanatory variables used in the regression analysis.

2.3 Data Source and Method of Data Collection

Primary data on WTP of domestic water beneficiary households were collected using structured questionnaire through personal interview. However, additional information was gathered through key informant interviews, focus group discussion and secondary data. The primary data that is utilized in the descriptive and empirical analysis of this study were mainly collected using structured questionnaire from sample households. The data collected included information on the socio-economic characteristics, water supply information, awareness on the watershed concept and willingness to pay for Angereb watershed protection of the households that ensures improved domestic water supply.

This study used particularly the contingent valuation survey to collect data related to willingness to pay for watershed protection. CVM is a demanding method that requires the analyst to go through many steps before reaching the final design of the survey instrument. The contingent valuation method which attempts to elicit information about respondents' preferences for a good or service by asking them how much they are willing to pay, has become one of the most widely used stated preference technique in valuing environmental goods and services. The guidelines prescribed by the National Oceanic and Atmospheric Administration (NOAA) panel and other literatures referenced in the thesis were also followed in the conduct of this study to address reliability issues on information derived from CV studies.

2.4 Method of Data Analysis

The survey data was analyzed using descriptive statistics and econometric models. In this study the respondents were asked single closed ended yes/no questions followed by open-ended maximum WTP questions to elicit respondents WTP for improved watershed protection services. Analysis of survey responses obtained from single dichotomous choice (yes/no) and open-ended valuation question formats require different models. Thus, given the nature of the data, two econometric models were used to analyze valuation survey responses one of which is a to bit model used to identify factors determining the maximum amount a household is willing to pay for improved watershed protection service. For dichotomous choice (yes/no) valuation responses of the proposed initial bid values the probit model better fits the problem at hand.

In Probit model, the dependent variable is limited variable which takes on only two values that represent a choice between two alternatives which depends on socio-economic characteristics of the respondent and the bid value assigned for each respondent. For example, in our case, for single bounded valuation survey response to model the choice status of each individual WTP for Angereb watershed protection services, individuals differ in age, educational level, household size, sex and other characteristics, which we denote generally as Z_i.

Econometric model for the single bounded survey response is developed as dichotomous variable as in random utility framework used in the utility differential model constructed by Hanemann 1984 [15]. In random utility model it is assumed that each individual know his/her utility function or preferences with certainty, and there are some components that cannot be observed by the researcher and treated as random variable (ibid). Let us denote this stochastic disturbance term by $\in_i$, and the household indirect utility function for watershed protection services at the status quo and after the improvement level by V (W^0, Y_i, Z_i) and V (W^1, Y_i, Z_i), respectively. Thus, household utility function for watershed protection services at the existing situation can be written as follows:

$$U (W^0, Y_i, Z_i) = V (W^0,Y_i,Z_i) + \in_0 \text{.......................... (1)}$$

And the household utility function for watershed protection services after the improvement can be written as follows:

$$U (W^1, Y_i, Z_i)= V (W^1, Y_i, Z_i) + \in_1 \text{.......................... (2)}$$

Where the random terms $\in_0$ and $\in_1$ are assumed to be independently and identically distributed with zero means. Households are faced with two choices: either to maintain at status quo level, W^0, or at after the improvement level of watershed protection services for ensuring improved domestic water supply service, W^1. To get improved watershed protection services from Angereb watershed, which secures them improved domestic water supply service, respondents were asked to pay some amount of money for improved Angereb watershed protection practices. With the introduction of a proposed watershed protection program, each respondent is confronted with a specified bid value, VWTP, which he/she could pay per month. It is assumed that the individual will accept a suggested initial bid value to maximize his/her utility from the improved watershed protection services that would ensure improved water supply service if the utility with the establishment of Angereb watershed management program, net of the required payment (VWTP), exceeds utility of the status quo reject it otherwise. That is;

$$V (W^1, Y_i - VWTP_i; Z_i) + \in_1 \geq V (W^0, Y_i; Z_i) + \in_0 \text{......... (3)}$$

The individual know which choice maximizes his/her utility. However, the researcher observes 'yes' or 'no' responses that is willingness to pay of the suggested bid price to improved watershed protection or to stay at the status quo. Our dependent variable is single dichotomous choice, and equals 1 if the i^{th} respondent is willing to pay money to support the watershed protection practices that ensure improved domestic water supply service and 0 otherwise. The household responses treated as random variable with probability distribution (Pr.) that a household is willing to pay for watershed protection services is given by:

$$\text{Pr. (yes)} = \text{Pr. } \{V (W^1, Y_i\text{-}VWTP, Z_i) + \in_1 > V (W^0, Y_i, Z_i) + \in_0\} \text{.............................. (4)}$$
$$= \text{Pr. } \{V (W^1, Y_i\text{-}VWTP, Z_i) - V (W^0, Y_i, Z_i)\} > \in_0 - \in_1$$

This probability statement provides an intuitive basis to analyze binary responses. Assuming the utility function is additively separable in deterministic and stochastic preferences.

Let us define $\eta = \in_0 - \in_1$ and $F\eta$ (.) be cumulative distribution function. This provides an underlying structural model for estimating the probability and it can be estimated either using a probit or logit model, depending on the assumption on the distribution of the error term ($\in$) or computational convenience. Assuming the normal cumulative distribution following, Oni, *et al.* (2005), the probit model can be expressed as follows;

$$Y_i{}^* = F (\beta_i X_i + \in_i) \text{.. (5)}$$

Where: β_i is vector of parameters of the model; X_i is vector of explanatory variables; $\in_i$ is the error term and is assumed to have random normal distribution with mean zero and common variance □ 2 (Greene, 2003)[12]. Y_i* is unobservable respondents actual WTP for improved watershed protection services. It is simply a latent variable.

Mean WTP and Aggregate WTP estimation

In this study empirical CV probit model (equation 6) was estimated based on the CV survey responses to derive mean of the WTP distribution. Assuming the probability of a respondents willingness to pay for Angereb watershed protection is a linear function of initial bid assigned to the respondent (VWTP), the following probit model (equation-6) was specified to calculate the mean WTP, using equation-7, of Gondar town potable water beneficiary households (Haneman, *et al.*, 1991 [16]; Haab and McConnell, 2002 [13]; Carlsson, 2009) [5].

$$\text{Prob (WTP=1/VWTP)} = \alpha + \beta \text{ VWTP} + \in_i \text{.................... (6)}$$
$$\text{Mean WTP} = -\alpha/\beta \text{.. (7)}$$

Where: α is the constant (intercept) term, and β is the initial bid (VWTP) coefficient.

Then from this mean, aggregate WTP was calculated by multiplying to the total domestic water users in the town. The total sample respondents non-parametric mean of open-ended maximum WTP can be calculated using the formula (Habb and McConnell, 2002) [13]:

$$MWTP = \frac{\sum_i (MWTPi) \times (ni)}{N} \text{.................................. (8)}$$

Where, MWTP = Mean willingness to pay for the total respondents; $MWTP_i$ = i^{th} Mean WTP; n_i = Number of respondents WTP the i^{th} amount; and N = Total number of sample respondents

The respondents' CV WTP survey responses from the open-ended maximum WTP are estimated as censored model such as the tobit model if the dependent variable takes non-negative values with some zeros or by using linear regression model if the dependent variable takes non-zero positive numbers (Siglman and Zeng, 1999) [24]. In our study, for those who happened to express their maximum WTP, we have recorded their potential expenditures; but for those who did not express their maximum WTP, we have no measure of the maximum amount that they are WTP at the time of the survey. The dependent variable, maximum WTP is therefore censored, but the corresponding information for the independent variables is present (Greene, 2003) [12].

So, let MWTP, Maximum Willingness to Pay, be a latent variable which is not observed when it is less than or equal to zero but is observed if it is greater than zero. It represents the expressed WTP or the reservation WTP for those who refused to express their WTP. For those respondents that failed to reveal their WTP, MWTP cannot be measured and is set equal to zero. Following Long (1997) [21], the Tobit model for observed MWTP is given by:

$MWTP_i = \theta_0 + \theta_i X_i + \epsilon_i$, if RHS > 0,
= 0 otherwise (i.e., RHS ≤ 0)………………..…………. (9)

Where: MWTP denotes maximum willingness to pay; RHS represents right hand side; θ_0 is the intercept term; θ_i represents vector of coefficients; X_i represents vector of independent variables and ϵ_i represents disturbance term

3. Results and Discussion

3.1 Socio-economic Characteristics

The socio-economic characteristics of total respondents as well as willing and non-willing to pay respondents are summarized in table 1 and table 2 for categorical and continuous variables, respectively. The majority of the respondents (59%) were male. Since males have decision-making power in the family, the proportion of male was slightly higher. The marital status figure reveals that 69.2% of the respondents were married. Concerning the employment structure, the proportion of governmental and non-governmental organization employees (58.5%) was greater than those running their own business, housewives and pensioners (41.5%). The survey results also show that 59 % households live in their own house while 41 % households live in rented houses. Share of respondents with own houses was 65.6% of the willing and 45.5 % of the non-willing. There was statistically significant association between ownership of house and willingness to pay decisions (p<0.01). Concerning membership in environmental organizations, a few (4.7%) of the respondents were members of an environmental organization. The association between membership in environmental organizations and WTP decisions was not statistically significant. The average bid value assigned randomly for total members of environmental organization (5.5 Birr/month) and non-willing to pay members of environmental organization (9 Birr/month) was higher than the average bid value assigned for the total respondents (3.92 Birr/month).

Table 1: Descriptive statistics of some socio-economic characteristics for total respondents, willing and non-willing to pay respondents (frequency, percentages, and chi-square)

Variables		Non-willing to pay (N = 77)	Willing to pay (N = 157)	Total (N = 234)	$\chi 2$
		F (%)	F (%)	F (%)	
SEX	Female	32 (41.6)	64 (40.8)	96 (41.0)	0.014
	Male	45 (58.4)	93 (59.2)	138 (59.0)	
MRSTAT	Unmarried	26 (33.8)	46 (29.3)	72 (30.8)	0.484
	Married	51 (66.2)	111 (70.7)	162 (69.2)	
Ownership of house	Rented	42 (54.5)	54 (34.4)	96 (41.0)	8.670***
	Owned	35 (45.5)	103 (65.6)	138 (59.0)	
ENVTORG	No	73 (94.8)	150 (95.5)	223 (95.3)	0.063
	Yes	4 (5.2)	7 (4.5)	11 (4.7)	
Occupation	Employee	40 (51.9)	97 (61.8)	137 (58.5)	2.643
	Business	30 (39.0)	52 (33.1)	82 (35.1)	
	Unemployed & pensioners	7 (9.1)	8 (5.1)	15 (6.4)	

Note: Variables in which willing respondents have significant differences from non-willing respondents: *** = at 0.01 levels of significance.

The data on age revealed a wide range of responses starting from 21 to 74 years where the average was found to be 40.34 years. The mean age of non-willing respondents is higher than mean age of willing respondents, but it is not statistically significant. The average household size of sampled respondents was 4.01 with a minimum of 1 household member and a maximum of 8 household members. The average family size was is lower but closer to the town average of 3.85 persons per household of CSA, 2010report of population statistics. The educational level attained by the respondent ranged from illiterate to tertiary level, with a mean value of grade 10.78. The average years of education for the willing was 12, which is statistically higher (p<0.01) than for non-willing average years of education (8.3). This suggests that on average the educational attainment of willing respondents is higher than the non-willing respondents. This might be because as years of education increases respondents will become more concerned of environmental degradation and aware of the benefits of watershed protection. In addition, more educational attainment has a positive impact on ability to pay which in turn increases their probability of willing to pay. The surveyed households on the average earn Birr 1361.84 monthly income. Willing households earn Birr 1538.34 mean income per month which is significantly higher (p<0.01) than Birr 1001.95 mean monthly income of the non-willing households. This shows that as monthly income of the household increases their probability of willingness to pay also increases. This might because higher income earners are more flexible to invest for a good/service which secures them a higher level of utility.

Table 2: Descriptive statistics of some socio-economic characteristics for total respondents, willing and non-willing to pay respondents (Mean, Std. Dev, and t-value)

Variables	WTP	Min	Max	N	Mean	St. Dev.	Mean diff	t-value
AGER	Non-willing	22	69	77	40.53	10.81	0.29	0.208
	Willing	21	74	157	40.24	9.61		
	Total	21	74	234	40.34	10.00		
EDUC	Non-willing	0	16	77	8.30	4.77	-3.70***	-5.579
	Willing	0	17	157	12	4.77		
	Total	0	17	234	10.78	5.07		
HHSIZE	Non-willing	1	8	77	4.01	1.91	0.01	0.027
	Willing	1	8	157	4.01	1.67		
	Total	1	8	234	4.01	1.75		
INCOME	Non-willing	150	2450	77	1001.95	615.34	-536.40***	-4.413
	Willing	250	5800	157	1538.34	975.01		
	Total	150	5800	234	1361.84	907.62		

Note:
- Variables in which willing respondents have significant differences from non-willing respondents: *** = at 0.01 level of significance
- mean diff = mean (non wiling)-mean (willing), H_0: mean diff=0andH_A: mean diff >< = 0

3.2 Domestic Water Supply Quality and Quantity Issues

As to water supply quality and quantity issues it is reported that a large proportion of the respondents (79.9%) have encountered water-related problems associated with the pipe water they get from GTWSSS in the past one to two years. Of the total surveyed respondents, 71.8% of the respondents said the existing water supply service from GTWSSS is not reliable with low pressure and not available as wanted. In addition, 31.6% of the respondents reported that they have encountered water quality problem such as dirty water in terms of color, odor or taste in the past one to two years (table 3).

Table 3: Water supply problems respondents' face, associated with the pipe water they get from GTWSSS, in the last one to two years

Problems	F		%
Water quantity problems (irregular water supply, low pressure)	168		71.8
Water quality problems (dirty water)	74		31.6
Total respondents with water problems	187		79.9
Total number of respondents		234	

According to the WB (1993)[28] the characteristics of the existing source of water supply system versus those of the improved water supply system including the quality and the reliability of the supply influence respondents WTP decision for improvement in existing water system. That is a respondent is willing to pay more if the water supply service from the proposed improved water supply system is reliable and good quality than the existing water supply system. Considering the water supply problem respondents face totally in terms of quality and/or quantity; a higher proportion of those willing to pay (85.4%) have been encountered water supply service problem than those non-willing to pay, 68.8% (table 4). The chi-square result shows that there is significant association (p<0.01) between WTP decision for improved watershed protection and existing water supply service problem a respondent encountered ($\chi2$ = 8.783).

Table 4: Comparison of sampled willing to pay and non-willing to pay respondents by the water supply problem experience

Indicators	water supply problem experience	Willingness to Pay			$\chi2$ (sig.)
		NoF (%)	YesF (%)	TotalF (%)	
Quality	No	53 (68.8)	107 (68.2)	160 (68.4)	0.011
	Yes	24 (31.2)	50 (31.8)	74 (31.6)	
Quantity	No	29 (37.7)	37 (23.6)	66 (28.2)	5.069**
	Yes	48 (62.3)	120 (76.4)	168 (71.8)	
Quality or/and quantity	No	24 (31.2)	23 (14.6)	47 (20.1)	8.783***
	Yes	53 (68.8)	134 (85.4)	187 (79.9)	

Note: Variables in which willing respondents have significant differences from non-willing respondents: *** = at 0.01, and ** = at 0.05 levels of significance.

3.3 Awareness of Watershed Benefits

The survey result revealed that most respondents were not aware of watershed resource benefits such as watershed protection benefits (Table 5). Of the total respondents 33.8 % of the respondents were aware of the various service provisions of watersheds. A higher proportion of the respondents (78.5%) who knew about watershed benefits believed that improved watershed resource management is important because of its watershed protection benefits such as providing sustainable water supply and improving water quality.

Table 5: Benefits of improved watershed resources management

Indicator	F		%
It provides and ensures a steady and quality raw water supply	62		78.5
It prevents soil erosion, flooding then avoids siltation problem	58		73.4
It provides recreational benefits	7		8.9
Total number of respondents who knew the watershed benefits		79	

The proportion of awareness about watershed benefits by those respondents with positive willingness to pay was higher than the non-willing to pay respondents (Table 6). The percentage of respondents who were aware of watershed benefits was higher (46.5%) for the willing than the non-willing respondents (7.8%). The chi-square results showed that the proportion of willing to pay and non-willing to pay respondents vary significantly with awareness level of the respondent to watershed benefits (P<0.01). This shows the probability of willingness to pay will increase, the more the respondent aware of the benefits of watershed resources. This is so because those who are aware of watershed benefits want to maximize their utility from those benefits. So they will pay more to secure those benefits.

Table 6: Comparison of willing and non-willing to pay respondents by awareness level of the watershed benefits

Variable		Willingness to Pay			χ2
		No F (%)	Yes F (%)	Total F (%)	
Awareness	Not aware	71 (92.2)	84 (53.5)	155 (66.2)	34.608***
	Aware	6 (7.8)	73 (46.5)	79 (33.8)	
	Total	77	157	234	

Note: Variable in which willing households have significant differences from non-willing households: *** = at 0.01 level of significance.

3.4 Results of the Probit Model

To identify the key factors that determine probability of respondents WTP for improved watershed protection which ultimately reduce sedimentation loading in Angereb dam and ensure sustainable water source to the dam; probit regression model was estimated.

Table 7: The probit regression model estimation results for determinants of households WTP choice for improved watershed protection (with robust standard errors)

Explanatory Variables	Coefficient	Robust Std. Err.	dF/dx	z-value	P>|z|
AGER	0.019	0.0133	0.0052	1.47	0.142
SEX†	-0.146	0.2629	-0.0383	-0.56	0.578
MARSTAT†	0.190	0.2915	0.0519	0.65	0.516
EDUC	0.081	0.0276	0.0214	2.93***	0.003
HHSIZE	-0.144	0.0871	-0.0382	-1.65*	0.098
INCOME	0.001	0.0003	0.0003	3.68***	0.000
VOLUME	0.005	0.0062	0.0014	0.85	0.393
ENVTORG†	-0.147	0.6754	-0.0413	-0.22	0.828
LSAT†	0.756	0.3152	0.2317	2.40**	0.016
AWARENESS†	1.326	0.4838	0.2866	2.74***	0.006
VWTP	-0.474	0.1016	-0.1257	-4.67***	0.000
Constant	-1.371	0.6208		-2.21**	0.027
No. of observations	234				
Log likelihood	-57.18				
Pseudo R-square	0.6143				
LR chi2(11)	182.12***				
Prob> chi2	0.0000				
Correctly predicted (%)	90.6				

Note:

- Significant variables affecting WTP decisions at 0.01 (***), 0.05 (**) and 0.10 (*) levels of significance.
- †dF/dx is for discrete change of dummy variable from 0 to 1

The result of the probit model showed that the variable education level (EDUC) of the respondent is positively related to the probability of respondents WTP for improved watershed protection as expected (table 7). This finding suggests that the probability of WTP by respondents with a higher educational attainment tend to be higher than those with lower educational attainment, thus confirming the importance of education in raising people's awareness about environmental protection benefits. A possible explanation is that respondents with more years of education can easily realize the benefits from improved watershed protection and negative impact of environmental degradation. And hence are more likely to attach high value for improved watershed protection benefits than those who have no or shorter years of education. In addition, higher educational attainment impress positive effect on probability of WTP since higher educational attainment indicates a higher ability to pay. The findings of Whittington *et al.* (1990)[27] and the WB (1993)[28] which was done on developing countries; with regard to households WTP for improved water services indicated that better educated households are more WTP for improved water services.

The sign of the variable household size (HHSIZE) turned out to be consistent with the prior expectation. That is, respondents with higher family size are less likelihood to say yes to the proposed bid. This finding suggests that as family size increases, the household expense will also increase so that they will not be willing to incur additional expense. This might be because of the high opportunity cost of using income for water service, due to high demand for food and other necessities in such families.

Household monthly income (INCOME) had expected positive sign and statistically significant at 1 % level of significance. This indicated that a household with higher monthly income is more likely to pay for watershed protection than a household with lower monthly income. Households with higher income have more flexibility in being able to invest in the future sustainability of the improved domestic water supply service from improved watershed protection practices. As individuals income increases the quality of goods/services they desire or demand for goods/services will rise as economic theory predicts. So, those with higher income are more likely to spend money for improved watershed protection, to secure improved domestic water supply service sustainably, than those with lower income. A study result by Jonse (2005); Benson (2006); Amponin*et al.* (2007) [1] and Habtamu (2009) [14] on WTP for environmental resource protection supports our result that household's income determines positively their WTP for improved environmental services.

The variable satisfaction level of the respondent (LSAT) with the existing water supply service was found to have significant ($P<0.05$) effect with a positive parameter estimate on the probability of WTP decision for improved watershed protection. This means that as respondent feel the existing water supply is unreliable and/or poor quality; he/she become more likely to pay for the watershed protection program which possibly ensures the improvement of the existing water supply service. This is perhaps because searching water from another source is time taking, costly and tiresome due to unreliability of the existing water supply service and perception about poor quality of existing water supply service which could result health hazards. This finding is consistent with Whittington *et al.* (1990) [27]; WB (1993) [28]; Kinfe and Berhanu (2007) [20]; and Simiret and Wogayehu (2011), which indicates that households will pay more for an improved water supply program when cost in terms of time and money of obtaining water from existing water supply service is higher and if the existing water supply service is unreliable and with poor quality.

The estimated coefficient of level of awareness of the respondent (AWARENESS) dummy variable had an expected positive effect related to the likelihood of saying yes to the proposed initial bid. That is, households who are aware of the benefits of watershed protection services are more likely to say yes to the proposed initial bid. One possible reason could be those respondents who are aware of improved watershed protection benefits wants to maximize their utility from these services. Those respondents who are aware of possible impacts of watershed resource degradation want not to face those problems. So, respondents who are aware of improved watershed management importance are more likely to pay for improved watershed protection to maintain the desired utility.

The estimated coefficient of the bid value (VWTP) was found to be statistically significant and had expected negative sign. This indicates that the probability of WTP to support watershed protection practices decreases (increases) as the bid price increases (decreases) under the hypothetical market scenario, which is logical as economic theory predicts. As economic theory predicts, demand for good/service decreases as the price of the good/service increases given other factors constant.

3.5 Results of the Tobit Model

Tobit regression estimate of the parameters of the variables expected to affect households extent of willingness to pay per household/month for improved watershed protection are shown in Table 8.

Table 8: Tobit regression model estimation results for determinants of household's extent of WTP for improved watershed protection (with robust standard errors)

Explanatory Variables	Coefficient	Robust Std. Err.	t-statistic	P>|t|
AGER	0.013	0.0092	1.38	0.169
SEX	-0.062	0.1676	-0.37	0.713
MARSTAT	0.249	0.2041	1.22	0.224
EDUC	0.048	0.0188	2.55**	0.011
HHSIZE	-0.049	0.0607	-0.80	0.425
INCOME	0.002	0.0001	13.99***	0.000
VOLUME	0.001	0.0037	0.14	0.892
ENVTORG	0.041	0.3791	0.11	0.914
LSAT	0.326	0.184	1.77*	0.077
AWARENESS	0.890	0.1741	5.11***	0.000
VWTP	0.353	0.1953	1.81*	0.071
Constant	-1.905	0.4575	-4.17***	0.000
Number of observations	234			
Log likelihood	-359.44264			
Pseudo R2	0.3312			
LR chi2(11)	356.08***			
Prob> chi2	0.0000			

Note: Significant variables affecting WTP decisions at 0.01 (***), 0.05 (**) and 0.10 (*) levels of significance.

The result of the Tobit model in table 8 showed that education level of the respondent (EDUC) is significant at 5 % level of significance. It had also the expected positive sign. The marginal effect of this variable indicate that all other factors being the same, for every additional year of schooling, the average maximum WTP goes up by 4.8 cents per household/month. This suggests that education increases the awareness of the respondent on the importance of watershed protection in ensuring improved domestic water supply service and thus leads to a higher WTP amount.

The parameter estimate for the household monthly income variable (INCOME) was significant ($P<0.01$) and positive, as expected, indicated that richer households are willing to pay more for watershed protection than poor households. This finding is in conformity with the general demand theory that income and quantity/quality of goods/services demanded are positively related except for inferior goods.

The satisfaction dummy variable (LSAT) in the Tobit model had positive sign as expected and statistically significant. The positive sign and the significance of this variable indicates that if the household get dissatisfied with the existing water supply service they would pay a higher amount for the improved watershed protection program which would ensure them water supply service improvement. Awareness dummy variable (AWARENESS) is positive and significant at 1% level. This is in conformity with a priori expectation; meaning that, if the respondent is aware of the benefits of improved watershed protection then his/her WTP will be high. Those respondents who are aware of watershed benefits are willing to pay 89 cents more for improved watershed protection than those who are not aware of watershed benefits, ceteris paribus.

3.6 Estimated Mean and Aggregate Willingness to Pay

The probit mean WTP estimate of the single dichotomous choice valuation was computed using the formula given in the methodology part above (See equation-7) and the coefficients of our probit model are given in table 9. Thus, the mean WTP from the single dichotomous choice valuation responses for improved Angereb watershed protection services was computed to be 6.46 Birr per household/month. Extrapolating this mean value to the whole households in the study area, aggregate WTP for improved watershed protection becomes 347,063.5 Birr per month.

Table 9: Probit parameter estimates for the respondents WTP decision for improved watershed protection

Variable	Coefficient	Std. Err.	Z-value
VWTP	-0.2053	0.0297	-6.91***
Constant	1.3269	0.1525	8.70***
Log likelihood = -119.48557 LR chi2(1) = 57.51 Prob> chi2 = 0.0000 Pseudo R2 = 0.1940			

Note: Significant variable affecting WTP decisions at 0.01 (***) level of significance.

The non-parametric mean of open-ended maximum WTP responses of total sample respondents is computed to be 2.98 Birr per household/month. Thus, using this mean WTP the aggregate WTP amount for improved Angereb watershed protection is 159,943.28 Birr per month. This is the amount the whole households in Gondar town are expected to pay per month when the suggested improved watershed protection program comes true.

With any data, different statistical procedures can produce different results. The closed-ended valuation format raises several statistical issues, for example, one might summarize the WTP distribution by using its mean. However, the mean is extremely sensitive to the right tail of the distribution; that is, to the responses of the higher bidders. For this reason, if the mean is to be used, a non-parametric approach is highly recommended for fitting the WTP distribution (Hanemann, 1984). Hence, the aggregate WTP for the Angereb watershed protection is preferably estimated by extrapolating the non-parametric mean WTP of open-ended maximum WTP responses to the domestic water user households of Gondar town; and it gives a total of 159,943.28 Birr per month.

4. Conclusion

Households in Gondar town were willing to pay for improved watershed protection so as to ensure a reliable domestic water supply service. As a higher proportion of domestic water users were willing to pay for improved watershed protection and the estimated aggregate WTP was a large amount of money which may assist the financing of Angereb watershed management program, policy makers should design and implement appropriate pricing policy for watershed resource services for efficient and sustainable utilization of watershed resources.

A higher proportion of the respondents have encountered water-related problems in terms of quantity and/or quality, and they were dissatisfied with the existing domestic water supply service they get from GTWSSS. The presence of water supply problems thereby dissatisfaction with the water supply service may be indicative of respondents' willingness to pay for improved watershed protection program. Most of the respondents were not aware of the fact that the condition of a given watershed where raw water is sourced for domestic water supply provision determines domestic water supply service safety, sustainability and reliability. Most respondents could not associate that domestic water supply problems may exist due to deforestation, soil erosion, poor land management practices etc in the watershed and were not aware of improvement in watershed management could reduce the domestic water supply problem.

Pricing of watershed protection services should be based on the households' WTP. The mean WTP results; can be used as the basis for pricing. However, while developing appropriate tariff structure, the ability to pay of service beneficiaries must be taken into consideration. The higher probit mean result of single dichotomous choice valuation and higher expected probability of WTP at open-ended valuation non-parametric mean; shows that there is still a possibility of increasing aggregate WTP by manipulating the influential determining factors like awareness variable.

The estimated non-parametric mean WTP for improved watershed protection, 2.98 Birr per household/month, was about 9.2% of the average monthly water expenditure of the sample households. Average water expenditure per month for the household, i.e. non-parametric mean WTP per household/month for improved watershed protection plus the average monthly water expenditure of sample households, is 2.6% of the households average monthly income, which is below 5% generally believed ceiling for the ratio of water expenditure to total household income in urban areas (Gossaye, 2007). This implies there is room for households to spend more if they are provided with a better water service.

Respondents, those willing to pay for improved watershed protection, were better educated and economically better off getting a higher mean monthly household income than the non-willing to pay respondents. In addition, the share of respondents who were aware of the benefits of watershed resources and those dissatisfied with the existing water supply service was higher for willing to pay than non-willing to pay respondents. The multivariate regression analysis provides a better insight about the determinants of respondents' willingness to pay. From probit regression results six variables were found to be significantly related to willingness to pay decision for the proposed initial bid. The factors that significantly and positively determined willingness to pay decision were years of education of the respondent, monthly income of the household, level of satisfaction of the respondent with the existing water supply service, and awareness level of the respondent about watershed benefits. On the other hand, household size and proposed initial bid significantly and negatively determined decisions of willingness to pay.

An important policy implication from the significant positive relationship between explanatory variables and WTP for improved watershed protection suggests the need to consider all the important variables in designing policies related to improved domestic water supply provision through improved watershed resource management. The provision of complementary services is important to boost the value attached by domestic water users to improved watershed protection like awareness creation of the importance of watershed in securing improved domestic water supply service. This recommendation stems from the fact that there is a positive relationship between WTP and variables like watershed benefit awareness and educational level of the respondent.

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