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Economic valuation of improved management of Dechatu drainage basin in Dire Dawa Administration, Ethiopia

This paper assesses households' awareness of the causes of drainage basin degradation and measures their willingness to pay for improved drainage basin management. Cross-sectional data were collected from 398 randomly-selected households. The spike and bivariate probit models were applied to determine the mean willingness to pay and factors affecting households' willingness to pay, respectively. Agricultural expansion, population pressure, changes in weather conditions and climate change were identified as the main causes of degradation of the Dechatu drainage basin in Dire Dawa Administration, Ethiopia. The study also identified appropriate mechanisms and bases of charging a drainage basin management fee from the sampled respondents. The mean willingness to pay from the spike model was computed to be ETB 111 per annum for five years whereas the mean willingness to pay from the open-ended elicitation method was computed to be ETB 78 per year. The higher mean willingness to pay from the spike model might be due to anchoring effect from the dichotomous choice format. The result suggests that any drainage basin management system needs to consider the monthly income, location, sex, initial bids, occupation, marital status and educational level of the affected households.

Keywords: contingent valuation method, improved drainage basin management, willingness to pay

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Introduction

A drainage basin, also called a catchment or watershed, is an area of land whose surface water runoff is channelled through a common outlet (Sheng, 1990; Swallow *et al.,* 2002; Postel and Thompson, 2005; Wani *et al.,* 2008). A drainage basin can occupy a few hectares or it may cover a very large area (NIEA, 2008). People and livestock are integral parts of a drainage basin or watershed; their activities affect the productive status of the basin and vice versa. The drainage basin plays a crucial role in determining food, social and economic security, and provides life support services to people (Wani *et al*., 2008). It is the main source of fresh water and clean air (Atisa, 2009). However, as demonstrated by MEA (2005), many natural resources, including drainage basins, are being degraded or used unsustainably.

Drainage basin degradation is defined as the loss of health and productive potential of land and water over time caused by a flow of inferior quality, quantity and timing of water (Sheng, 1990; Aglanu, 2014). Reduced economic opportunities and increased social problems are the effects of degradation (Sheng, 1990), and it is a serious threat to the survival of millions of people (Kapta, 2004). Drainage basin management is therefore very important for achieving environmental, social and economic goals (Wani *et al*., 2008). It involves protecting and rehabilitating the basin in a way that increases production, generating both short-term and long-term benefits for the people living there (Nick and Woldehanna, 2012) and/or downstream. Effective drainage basin management requires an integrated and coordinated planning system (NIEA, 2008). However, because of their quasi-public good and externality features, the benefits of drainage basin management are rarely quantified (Georgiou *et al*., 1997). In other words, it is very difficult to exclude an individual from using the drainage basin services. Besides, the effect on the economic profit and utility of the users of these services does not necessarily enter the decision calculus of the supplier of the services.

In Ethiopia no attempt has been made to estimate the economic value of improved drainage basin management using environmental valuation techniques. The free distribution and underestimation of the value of drainage basins enhances the complexity of the degraded resource management decision. This study therefore tries to fill this gap and provides useful information on the value of improved management of the Dechatu drainage basin for management agencies, researchers and the communities that are affected by the degradation of the drainage basin.

Methodology

Study area and sampling techniques

The study was conducted in Dire Dawa Administration which is located in eastern Ethiopia between 9°27' N and 9°49' N latitude and 41°38' E and 41°19' E longitude. It is characterised by two broad agro-ecological zones mainly based on altitude, moisture and physiography (DDAEPA, 2011). A map of Dire Dawa Administration showing *kebeles*[1] is shown in DDAEPA (2011) and one of the Dechatu drainage basin is available in Alemu (2015). There are three groups of streams or tributaries flowing into the Dechatu drainage basin:

- Kersa – Legaodamirga – Harela – Jellobelina – Genet menafesha – Dechatu;
- Dengego – Harela – Jellobelina – Ijaanani – Dechatu;
- Awale – Bishanbahe – Biyoawale – Adada – Legabira – Dechatu.

From each of these three groups, one representative *kebele* was selected to obtain a sample of respondents from the rural *kebeles*. Harela, Jellobelina and Biyoawale *kebeles* were selected to represent the drainage basin. Three urban *kebeles* (05, 06 and 09 *kebeles*) were also selected to rep-

[1] *Kebele* is an administrative hierarchy in Ethiopia. The country is a federal state of regions where every region is structured into zones and zones are divided into districts. Every district is again divided into *kebeles*.

resent the drainage basin in the urban area. Given the total number of households of the study area, 398 sample households were selected. The sample allocation to urban and rural areas was based on the probability proportional to size sampling technique. Accordingly, 282 and 116 households from urban and rural areas, respectively were included in the sample. A similar approach was used to determine the sample size from each *kebele*.

Types and methods of data collection

Primary data on the willingness to pay (WTP) of sample households were collected through face-to-face interviews in the period June-November 2014. A structured questionnaire was developed and pre-tested to evaluate its effectiveness and identify the 'initial bids', i.e. the amounts of money the respondents would be willing to pay per month towards the improved management of the drainage basin. The initial bids (ETB 30, 70, 100, 140 and 180[2]) were identified using focus group discussion involving 60 key informants (farmers plus urban dwellers). The chosen bids were randomly assigned to the respondents such that each bid is allocated to an equivalent sub-sample. Also, secondary data were collected from the Ethiopian Central Statistical Agency and the Dire Dawa Administration Bureau of Agriculture. The contingent valuation (CV) scenario was presented to the respondents using the dichotomous choice referendum format. The double-bounded dichotomous choice format is useful to make clear bounds on unobservable true WTP, and it sharpens the true WTP and efficiency gain (Haab and McConnell, 2002; Tietenberg, 2003).

Methods of data analysis

The survey data were analysed using descriptive statistics and econometric models. In the CV survey the respondents may be offered a considerable number of zero responses (Johnson and Whitehead, 2000). These zero responses may be genuine or protest zeros. Hence, to treat these two zero responses, an appropriate framework of analysis should be adopted (Strazzera *et al*., 2003). Non-participation can have a substantial impact on the results of contingent valuation method (CVM) studies. If it is inadequately accounted for in the estimation process, an important difference in the final WTP estimates results (Haab 1999; Dziegielewska and Mendelsohn, 2007). A genuine zero value reflects the true value that the public good has for the respondent. The problem is with protest zero responses (Jorgensen and Syme, 2000). In the traditional CVM analysis, protest responses have tended to be excluded from the sample data set. However, this creates a problem if protest responses encourage a selectivity bias (Calia and Strazzera, 2001). Although there is no general consensus in the CVM literature on the most appropriate way of dealing with this problem of non-participation, a solution that has gained increasing popularity is the spike model.

The spike model was proposed by Kriström (1997) and it explicitly allows for the possibility that some of the respondents are indifferent to the good being valued, i.e. this model assigns a non-zero probability to zero WTP responses. Following Kriström (1997), the simple spike model was used in the study to allow a better handling of the zero responses that are common when using the dichotomous choice referendum format. A respondent was asked whether or not he/she is willing to contribute to the improved management of the drainage basin. The WTP for a change in environmental quality (such as improved management of drainage basin) $q^0 \rightarrow q^1$ (q belongs to R^1) can be expressed as:

$$V(y - WTP, q^1) = V(y, q^0) \tag{1}$$

where $V(y, q)$ is an individual's indirect utility function and y is income. If there is a continuum of individuals who associate different values to the improved management of the drainage basin, the probability that an individual's WTP does not exceed an amount A is given by:

$$Pr(WTP \leq A) = F_{wtp}(A) \tag{2}$$

where F_{wtp} is a right continuous non-decreasing function. As a result, the expected WTP can then be expressed as:

$$E(WTP) = \int_0^{\infty} 1 - F_{wtp}(A)dA - \int_{-\infty}^{0} 1 - F_{wtp}(A)dA \tag{3}$$

To be able to estimate $F_{wtp}(A)$ when binary valuation questions are used, different values of A were allocated to each sub-sample. The spike model assumes that the distribution function of WTP has the following form:

$$F_{wtp}(A) = \begin{cases} 0 \; if \; A < 0 \\ P \; if \; A = 0 \\ G_{wtp} \; if \; A > 0 \end{cases} \tag{4}$$

where P belongs to (0, 1) and $G_{wtp}(A)$ is a continuous and increasing function such that $G_{wtp}(0) = P$ and $\lim A \rightarrow \infty \, G_{wtp}(A) = 1$. This creates a jump-discontinuity or a spike at zero.

In this study, after the CVM scenario was presented to the respondents, two valuation questions were offered for the spike model. These valuation questions were (a) whether the respondent is willing to participate in the market for improved drainage basin management; and (b) whether the respondent is willing to contribute the initial bid per month.

For each respondent, i, an indicator of S_i was defined to determine whether the respondent is 'in-the-market' or not.

$$S_i = \begin{cases} 1 \; if \; WTP > 0 \\ 0 \; if \; WTP \leq 0 \end{cases} \tag{5}$$

The respondent is 'in-the-market' if the additional amount that he/she is asked to contribute towards the improved management of the drainage basin is lower than his/her WTP. A linear non-linear model was used to identify the effect of respondents' socio-economic characteristics on their WTP for improved management of the drainage basin. The model is specified as:

$$S_i = \gamma_0 + \gamma_1 V_{1,j} + \gamma_2 V_{2,j} + \ldots + \gamma_k V_{k,j} + \varepsilon_{S_{i,j}} \tag{6}$$

where $V_{S_i} = \{V_1, V_2, \ldots, V_k\}$ is also a vector of explanatory vari-

[2] EUR 1 = ETB 25.56 during the study period

ables not necessarily distinct from X_{T_i} below; γ is an unknown parameter of the model. After the respondents decision to participate in the hypothetical market ($S_i = 1\,(yes)$ the latent variable T_i was used to indicate the respondent's WTP for the initial bids A. That is:

$$T_i = \begin{cases} 1\ if\ WTP > A\ and \\ \quad 0\ otherwise \end{cases} \tag{7}$$

This latent variable T_i is specified as:

$$T_i = \alpha + \beta A_i + \gamma_1 X_{1,i} + \gamma_2 X_{2,i} + \ldots + \gamma_M X_{M,i} + \varepsilon_{T,i} \tag{8}$$

where $X_{T_i} = \{X_1, X_2, \ldots, X_M\}$ is a vector of explanatory variables, A_i is the initial bids offered to the respondent in order to enjoy an improvement in the environmental quality $q^0 \rightarrow q^1$; in this study, the improved management of drainage basin. And α, β and γ are unknown parameters of the model. The disturbance terms are assumed to have a bivariate normal distribution with a correlation parameter ρ. That is, $(\varepsilon_{S_i}, \varepsilon_{T_i}) \sim BVN(0, 0, 1, 1, \rho)$. Therefore, with the introduction of these decision rules, the spike model becomes a bivariate specification with sample selection:

$$\begin{Bmatrix} S_i = 0\ if\ S^* \leq= 0 \\ S_i = 1\ if\ S^* > 0 \rightarrow \begin{Bmatrix} T = 1\ if\ T^* > 0 \\ T = 0\ if\ T^* \leq 0 \end{Bmatrix} \end{Bmatrix} \tag{9}$$

The log likelihood for the sample is then given by:

$$L = \prod_{S_i=0} P(S^* \leq 0) \prod_{S_i=1} \Big[\prod_{T_i=1} P(S^* > 0, T^* > A) \prod_{T_i=0} P(S^* > 0, T^* \leq A) \Big] \tag{10}$$

which implicitly contains the joint probability of S^* and T^* and the marginal probability of S^*

Results

Socio-economic characteristics of sample households

The results show that 8.29 per cent of the sample respondents were protest zero. The entire sample, including the protest bidders, was included in the analysis to avoid the problem of sample selection bias. The descriptive analysis indicates that 85.7 per cent were male and 14.3 per cent were female respondents. Among these respondents 85.1 per cent were married. The remaining 3.5 per cent, 9.1 per cent and 2.3 per cent of the respondents were widow/ers, single and divorced, respectively. The age of the respondents ranged from 18 to 77 years with an average of about 42 years. The mean difference in age between the willing and not willing respondents was not significant (Table 1).

On average, households were composed of about 5.2 persons which was greater than the national average of 4.7 persons reported in FDREPCC (2008). This is due to the fact that polygamy is a custom in the study area. When more people are living in the drainage basin this can have an effect on the management of the basin. The educational status of the sampled respondents ranges from illiterate to 12+3 years of schooling, with an average of about 6 years. The mean difference in educational level between the two groups was statistically significant at the 5 per cent level.

On average the cultivated land area of the sampled households amounted to 0.13 ha, indicating that the average farm size of the study area is lower than the national average of 0.8 ha (CSA, 1995). This might be due to the fact that 70.9 per cent of the respondents were from urban areas. It shows that it is very difficult to produce sufficient agricultural output in the area. The mean difference of cultivated land for the willing and not willing groups was statistically significant at the 5 per cent level. Moreover, the result indicates that the total monthly income of sample households was ETB 666,290 per month. On average the income of the surveyed households was estimated at ETB 1674 per month (Table 1). Taking the average family size of 5.2 the average per capita income was ETB 322 per month. Higher monthly income was recorded because of smuggled products and cash crops production. The mean difference of monthly income for the willing and not willing respondents was statistically insignificant.

Households' perception on water availability and quality

About 84 per cent of the respondents were connected to the water distributer. On the other hand, the remaining 16 per cent fetched water from rivers and deep wells. The average water consumption of the sampled respondents was 1.51 m^3 per month. The majority of the respondents (54.8 per cent) stated that water is available to them for 8 hours per day. About 3 per cent of the respondents reported that water is constantly available (Table 2). This result indicates that availability water is a problem. However the majority of the respondents (73.6 per cent) reported that there is no problem with the quality of water (Table 2), and that they are using it directly from the pipeline. The remaining respondents reported that there is a problem with water quality. The overall result shows that there is no serious problem in terms of the quality of the available water.

Table 1: Socio-economic characteristics of the respondents by group of households (n = 398).

Variable	Willing households		Not willing households		Total sample		t-value
	Mean	SD	Mean	SD	Mean	SD	
Average age of the respondents (years)	41.8	11.5	41.5	13.3	41.7	11.8	0.86
Educational attainment (years of schooling)	6.6	5.0	5.0	4.9	6.4	5.0	2.40**
Family size (persons)	5.3	1.6	4.7	1.2	5.2	1.6	2.64***
Cultivated land area (ha)	0.15	0.31	0.04	0.13	0.13	0.29	2.53**
Monthly income of respondents (ETB)	1,676	1,664	1,012	906	1,674	995	0.09

*** and ** indicate statistically significant at 1% and 5% probability level, respectively
Source: own survey data

Table 2: Respondents' assessments of the availability of water and its quality (n = 398).

Daily duration of water availability	Respondents (%)	Quality of the water	Respondents (%)
Constantly available (24 hrs)	3.3	Highly acceptable	73.6
Moderately available (16 hrs)	42.0	Moderately acceptable	21.6
Available (8 hrs)	54.8	Acceptable	4.8

Source: own survey data

Table 3: Respondents' assessments of the causes of Dechatu drainage basin degradation and of the appropriateness of possible protection measures (n = 398).

Causes of degradation	Respondents agreeing (%)	Possible protection measures	Respondents agreeing (%)
Expansion of agriculture	39.9	Government regulation	23.6
Population pressure	68.6	Tree planting	47.5
Soil and water degradation	53.3	Soil and water conservation	74.4
Changes in weather conditions	7.5	Training of users	37.7
Climate change	13.1	Other sources of income for the communities	17.1

Source: own survey data

Causes and protection measures of drainage basin degradation

The data show that 90.8 per cent of the respondents were aware of the causes of Dechatu drainage basin degradation. They believe these causes are expansion of agriculture, population pressure, soil and water degradation, changes in weather conditions and climate change. Specifically, 39.9 per cent of the respondents believe that expansion of agriculture is the cause. In the case of soil and water degradations 53.3 per cent of the respondents responded 'yes' (Table 3). The result of the study is consistent with the findings of EPA (2012). Solutions were also elicited from the aware respondents for the possible improvement of Dechatu drainage basin. A majority of the respondents suggested that strong government regulation, soil and water conservation, tree planting and training users were the most appropriate protection measures (Table 3).

Assessment of institutional arrangements

Mechanisms proposed to the respondents for collecting the fee to pay for improved management of the drainage basin were: (1) a trust fund (2) a surcharge to be added to water bills (3) recover the cost through income tax. About 18.3 per cent of the sampled respondents were willing to contribute to a trust fund, a further 31.7 per cent believed that a surcharge should be added to water bill while the remaining 11.3 per cent opted for recovery through income tax as the appropriate mechanism to collect the fee. This suggests that the majority of the respondents were prepared to contribute financially to solving the water supply problems. However, 38.7 per cent of the respondents selected none of the above mechanisms.

The sample respondents were also consulted on their preferred basis for charging the fee for improved drainage basin management. The options were: (1) volume of water used (2) income (3) number of persons in the households (4) a fixed rate. The result shows that 38.7 per cent of the respondents selected none of the above bases for charging the fee. About 25.4 per cent selected the first basis, and 19.3 and 10.1 per cent of them selected the second and third bases respectively. The remaining respondents chose the fixed rate as the basis for charging the fee.

Table 4: Households' responses to the offered bids from the double bounded elicitation method (n = 398).

Value of bid (ETB)			Share of sampled households (%)			
Initial	Second higher	Second lower	yes-yes	yes-no	no-yes	no-no
30	60	15	11.8	6.3	0.2	1.8
70	140	35	4.3	8.8	2.8	4.3
100	200	50	2.5	8.0	3.3	5.8
140	280	70	1.8	3.5	7.3	7.0
180	360	90	1.3	2.8	7.0	9.5

Source: own survey data

Table 5: Parameter estimates of the spike model for the improved management of the Dechatu drainage basin (n = 398).

	Coefficient	Std. error	z	P>z
Initial bid	0.01728	0.001249	13.83	0.000
Constant	1.76828	0.138737	12.75	0.000
A	0.14576	0.017274	8.44	0.000
WTP	111.477	6.142573	18.15	0.000

Wald chi square(1) = 191.21; Log likelihood = -343.47; Prob > chi square = 0.000
A: 1/(1+exp(_b[s:_cons]))
WTP: 1/(_b[eq1:initialbid])*log(1+exp(_b[s:_cons]))
Source: model output

Households' WTP for improved management of the drainage basin

About 85 per cent of the sampled households were willing to pay for improved drainage basin management. The descriptive statistics of households' responses from the double bounded dichotomous choice format shows that 51 per cent of the respondents were willing to accept the initial bids. The remaining respondents rejected the initial bids. The average of the initial bids assigned to the respondents was ETB 104. From discrete responses of WTP, the study found that 21.6 per cent of the respondents accepted both the first and second bids. Besides, 29.4 per cent of the respondents responded 'yes-no', whereas the remaining respondents responded 'no-yes' and 'no-no' to the offered bids (Table 4).

The mean WTP for improved management of drainage basin was ETB 111 per year per household for a five year period (Table 5). The result shows that the mean WTP calculated from the spike model was significantly greater (at the 1 per cent level) than the mean value from the open-ended response. This implies that an open-ended elicitation method

Table 6: Factors affecting the sample households' maximum WTP for the improved management of the drainage basin according to the bivariate probit model (n = 398).

Explanatory variable	eq1: WTP participate		eq2: WTP initial bid	
	coefficient	P>z	coefficient	P>z
Location	1.43	0.000***	1.68	0.000***
Age	0.01	0.441	0.001	0.917
Sex	0.43	0.05**	0.25	0.26
Maritalstatus	-	-	-	-
Single (1)(base)	-	-	-	-
Married (2)	0.39	0.20	-0.09	0.748
Widow/er (3)	0.24	0.659	0.36	0.527
Divorced (4)	-0.45	0.39	-0.98	0.068*
Occupation	-	-	-	-
Unemployed (1) (base)	-	-	-	-
Self-employed (2)	0.28	0.297	0.49	0.05**
Governmentemployee (3)	-0.15	0.627	0.27	0.39
Privatesectoremployee (4)	-0.24	0.836	-5.11	1.00
Education	0.11	0.000***	0.07	0.006***
Familysize	0.10	0.19	-0.03	0.58
Totalincome	0.0002*	0.142	0.0003	0.000***
Waterconsumption	0.22	0.149	0.25	0.021**
Bid	-0.01	0.006***	-0.02	0.000***
_cons	-1.65	0.009	-0.51	0.37

Wald chi square (22) = 251.04; Log likelihood = -293.87; Prob > chi2 = 0.000
***, ** and * indicate statistically significant at 1%, 5% and 10% probability level, respectively
Source: model output

has the advantage of avoiding the anchoring effect. This result is consistent with other studies (Amponin *et al*., 2007; Alem, 2012). Using the spike model, the mean WTP of the urban and rural residents was computed to be ETB 97 and ETB 143 respectively. This indicates that households in the rural areas were more willing to pay than urban households. This might be due to the fact that the livelihoods of the urban residents are less dependent on the drainage basin than those of the rural households.

Households' willingness to pay derived from open-ended questions

The mean WTP of the respondents was ETB 78 per household per year for five years. The total WTP of the 398 sample respondents was estimated to be ETB 30,861 per year with a minimum of ETB 0 and maximum ETB 360 per household. Just over 30 per cent of respondents were willing to pay a monthly fee towards the improved management of the drainage basin in the range ETB 41-80, but thereafter the 'yes' response of the respondents decreased as the offered bids increased (Figure 1).

Different reasons were elicited from the willing households on their maximum WTP for the improved management of the drainage basin. Because of inadequate income, about 46.5 per cent of the respondents reported that they could not afford more than what they stated. On the other hand, 31.4 and 7.3 per cent respectively of the respondents stated "I think it is worth that amount" and "others should pay" as their reasons for the maximum WTP. About 46 per cent of the respondents stated "I could not afford more" as their reason for their maximum WTP. However, about 15 per cent of the sample respondents were not willing to pay for the improved management of the drainage basin, and provided a zero response. About 45 per cent of the not willing households responded with a genuine zero bid. Whereas, the remaining respondents stated protest zero[3].

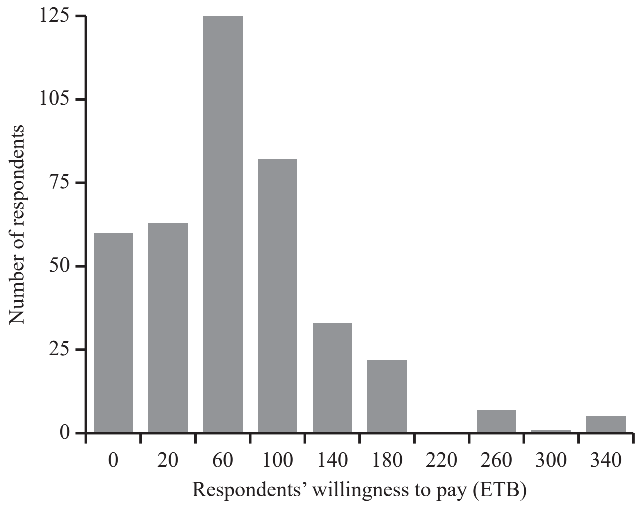

Figure 1: The sample households' maximum WTP for the improved management of the drainage basin, mid-points values of each group, i.e. 20 represents the range 1-40 (n = 398).

Determinants of households' willingness to pay

The bivariate probit model was used to identify the determinants of households' WTP for improved drainage basin management. The monthly income of the respondents (*Totalincome*) is positively and significantly related to the households' WTP to the offered bids (Table 6), indicating that respondents with higher monthly incomes were either more likely to be willing to pay, or simply have a greater ability to pay, than those with lower incomes. Amponin *et al.*

[3] The criteria for selecting protest zero was based on the discussion on NOAA panel guide in Arrow *et al*. (1993).

(2007) and Alem (2012) also found a significant association between households' income and WTP.

The education level of the respondents (*Education*) was positively and statistically significantly related to WTP. One reason for this might be that literate individuals know more about the significance of resources and are more concerned about environmental degradation (and hence drainage basin management) than are illiterate ones. On the other hand, it might be that education enables respondents to make independent decisions and paves the way to have greater access to job opportunities. This result is in agreement with the findings of other studies (Tegegne, 1999; Carlsson, *et al.* 2004).

The coefficient of sex (*Sex*) had a positive sign which was statistically significant at the 5 per cent level. This indicates that male respondents were more willing to contribute to improved management of the drainage basin than their female counterparts. This might be that male respondents have the power to make decisions on the expenditure of the family. Or, due to the high involvement of women in home production activities, they might face a money shortage that restricted them from contributing to drainage basin management.

Households that are located in the urban area (*Location*) were expected to have high WTP because they were thought to have more income than those in rural areas. However, our result shows that rural households were more willing to pay for improved management of the drainage basin than urban residents. This is because the livelihoods of the rural residents are more dependent on the drainage basin than urban residents. Divorced respondents were less likely to be willing to pay for improved management of the drainage basin than single respondents. The coefficient of this variable was negative and statistically significant at the 10 per cent level.

The result also shows that self-employed respondents were more willing to pay than the unemployed for the improvement of the drainage basin. The coefficient of this variable was statistically significant at the 5 per cent level. The coefficient of starting bids (*Bid*) had a negative sign and was statistically significant at the 1 per cent level in the first and second equations. This indicates that as the starting bid price increases, the probability of household's WTP reduces. This may indicate the existence of income scarcity or cash poverty. Besides, the result shows that demand for improved management of the drainage basin decreases as the starting bids increase. This is consistent with the findings of various authors (Whittington *et al*., 1990; Carlsson *et al*., 2004; Amponin *et al*., 2007; Alem, 2012).

Aggregate WTP for improved management of the drainage basin

An important issue related to the measurement of welfare using WTP is aggregation of benefit. According to Mitchell and Carson (1989), there are important issues to be considered in estimating a valid aggregation of the benefits of the environmental resource. However this could be affected by population choice bias, sampling frame bias, non-response bias and sample selection bias. In this study, the sample respondents were selected using a random sampling method. Besides, a face-to-face interview method was used to collect the data. To avoid sample selection bias, protest zero responses were included in the analysis. Hence, none of the above CVM biases was expected in this study. Mean WTP was used as a measure of aggregate value of improved management of drainage basin since the good dealt with is not a pure public good. The aggregate WTP was calculated by multiplying the mean WTP by the total number of households in the population (Table 7). Therefore, the aggregate benefit for improved management of the drainage basin of the total population of the study area was computed to be ETB 5,869,235 per year.

Table 7: Annual aggregate WTP of all households in the Dechatu drainage basin as calculated using the spike model and the open-ended elicitation method.

Location	Total households	Total WTP	
		spike model	open-ended elicitation method
Rural	22,091	3,150,618	2,103,505
Urban	53,602	5,206,362	3,766,613
Rural + urban	75,693	8,438,256	5,869,235

Source: survey data

Discussion

The CVM was used to elicit households' WTP for improved management of the Dechatu drainage basin in Dire Dawa Administration. The respondents believe that the drainage basin has been degraded because of agricultural expansion, population pressure, soil and water degradation, changes in weather conditions and climate change. Therefore, the government should introduce new practices such as environmental rehabilitation, family planning and resettlement. Besides, the residents should carry out soil and water conservation and tree planting to rehabilitate the degraded drainage basin.

The preferred mechanism for collecting the money from households for improved management of the drainage basin differed from household to household. Any management body should collect the money for this purpose using different mechanisms because using one mechanism may underestimate or overestimate the value of the resource. In addition, the basis of charging the fee should also differ from individual to individual.

The annual WTP value of households from the double bounded dichotomous choice format was greater than the annual total WTP from the open-ended format. We conclude that the double bounded dichotomous choice is affected by the anchoring effect. Thus, when designing a new management policy, decision makers and researchers should give more attention to solving the problem of the anchoring effect from the double bounded dichotomous choice format. Furthermore, the WTP value from rural households was higher than from their urban counterparts. It is therefore very important to elicit the value of drainage basin management from households whose livelihoods are more dependent on the drainage basin. However, this should not be considered as an end for improved drainage basin management. The value can be used in future cost-benefit analyses for policy formulation, especially as regards improved drainage basin management, and can be considered as the societal benefits of improved drainage basin management. Our findings can also be used to compare the cost of the improved drainage basin management plan, for example to the aggregate WTP of the households which is ETB 5,869,235 per year. If the aggregate WTP is lower than the proposed cost of the management plan, effort is required from the management agency or government to solve the social acceptability problem.

The households' WTP is affected by the socio-economic characteristics of the different households. This result leads us to conclude that an understanding of the socio-economic characteristics that significantly affect households' WTP is a necessary and first step to achieving improved drainage basin management.

Acknowledgements

We would like to acknowledge Haramaya University for providing us financial support. We also thank the enumerators for the effort they made to collect primary data. Dire Dawa Agricultural Office deserves special thanks for providing data for the analysis.

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