Tanzanian Economic Review, Vol. 9 No. 2, December 2019: 33–52

Reconciling Willingness to Pay and Conservation Costs for Sustainable Watershed Management in Tanzania

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Abstract

Effective sustainable natural resource management asks for an integrated approach to allow the involvement of actors in the management process. This paper intends to measure willingness to pay (WTP) and its determinants for watershed conservation, and then link it to the calculated costs of conservation. A cross-sectional data from 200 households residing in Igunga town are analysed using the probit model. The key findings show that, on average, households are willing to pay TZS4,920 per month, which approximately equals TZS260m per year, for the entire number of households in the area. The WTP would cover the calculated cost of conservation, which approximately equals TZS233m per month by more than 100%. Factors that influences WTP positively includes household income level, household head's number of years of schooling, and house ownership. On the other hand, the price of water per 20 litres and outbreak of water-related diseases decreases household WTP. The implication from the study findings is that, effective conservation of watershed in the study area would require, to large extent, community participation. Policies geared towards improving household income and education access would further benefit water resources management in the area.

Keywords: *integrated water resources management, willingness to pay, conservation costs, Tanzania*

1. Introduction

Scientists and decision-makers are worried about the loss of valuable ecosystem services due to environmental degradation. Water ecosystem is important for sustainable socio-economic development such as in domestic water use, hydropower generation, industrial water use, mining, recreation, and the environment for the sustenance of ecosystems. Ecosystem resources offer avenues, mostly to poor people, to undertake economic activities for poverty reduction and sustainability of livelihoods (Chambers, 1992; Rennie & Singh, 1996). However, many watersheds are under increasing pressure; consequently, they are degrading due to over-use. This further threatens the sustainability of most of the goods and services of ecosystems that are central in supporting the livelihoods and welfare of the majority poor people (Hepelwa, 2012; 2014). Globally, efforts are underway to ensure watershed resources are managed properly, and the prominent framework used in such endeavours is the Integrated Water Resources Management (IWRM).

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The IWRM framework emphasizes the use of market-based incentives geared towards providing land users with economic incentives to implement sustainable land use practices. These initiatives are often based on market principles that allow land users to benefit directly from their practices that reduce land degradation. Economic incentives may include direct monetary payments, technical assistance, or preferential market access. Various market-based tools such as payment for ecosystem services, certification, traceability, public-private partnerships, and consumer awareness campaigns have been developed towards this end. For example, an innovative approach to finance conservation is emerging in the form of payments for environmental services (PES). This measure aims to influence the choices of land managers in favour of conservation by offering a financial reward.

Within the PES, payments for watershed services (PWS) represent a significant chance to achieve both poverty alleviation and nature conservation (Pagiola & Platais, 2002). Yet, the number of established PWS schemes around the world is limited, and the ability of such schemes to alleviate poverty remains uncertain (Landell-Mills & Porras, 2002). The PES has been reported to face financial constraints since it depends on voluntary contribution from beneficiaries who pay to compensate upstream land owners to change land use. In addition, sustainable land management (SLM) practices are also employed as means of managing watersheds. By using SLM practices, communities in upstream can improve watershed services, and hence ensure improved water security for downstream water users (Branca et al, 2009). Thus, these activities can improve the quality of water and help manage water quantity and quality, thus improving water supply for other uses (Smithet al., 2006).

The prospects from conservation programmes through, for example, the PES, are appealing. Experience has shown that the amount of money contributed to facilitate conservation programmes does not meet the expectations of land owners, consequently impairing conservation objectives. This is because money contribution is determined in an ad hoc manner, with little consideration being made on the real cost of a conservation programme. There is a general lack of proper assessment of the cost of activities envisaged to be done to address the cause and source of degradation across an entire river basin. For example, while efforts are made to ensure improved situations upstream, PES do not normally consider activities at the middle part of the river, which equally affect water quality and quantity. This discourages buyers of a service as they see no improvement in terms of the quality of the service they buy. A pilot PES in Uluguru Mountains was carried out in Tanzania from 2008 to 2012 (Lopa et al., 2012).There is no clear information whether this will continue in the near future, and a majority of villagers in this programme no longer engage in interventions, hence putting the watershed into risk of being degraded (Hepelwa, 2013). Failure to take into account the real cost of conservation has made the PES to stop operations because of the lack of funds as a result of potential contributors refusing to pay due to unimproved quality and quantity of water flow against expectations.

In general, effective watershed management is still a challenge in many places. The problem is more complex due to the multitude of services and goods provided by watershed resources on which human beings depends. In some cases, there are variations of what a community depends on in watershed resources. For example, some people may depend on a particular watershed only for the provision of water services for domestic uses, while others use it for commercial purposes and agricultural activities. Because of the heterogeneity impeded within the uses of a watershed resource, a specific implementation of an IWRM must be called for. Therefore, this means that even the sustainable management of these resources need to be oriented in a way to suit specific attributes found in a particular site. However, a uniform kind of implementations strategies is applied with little or no recognition of the differences existing within different watersheds. Community involvement in the management of natural resources is necessary, therefore, and requires an in-depth understanding of the socioeconomic attributes of the community around, or near, a natural resource to device effective and sustainable water resource management. Thus, a new way to ensure conservation for continued flow of quality goods and services from watershed resources is paramount.

The current paper presents the innovation needed while instituting sustainable watershed management. The innovation is based on reconciling the WTP and conservation costs. The WTP approach would result to sustainable funding only when participants are aware of the type of management needed and the conservation cost to be incurred. Contrary to existing literatures on watershed management schemes in the country (see, e.g., Lokina et al., 2006; Ndetewio et al, 2013), this paper carefully designs a WTP for conservation of the source of water in Igunga town, which is then linked with costs of conservation. The inclusion of conservation costs facilitates resource ownership to stakeholders, brings sharply on board all actors to one common goal, and enhances the effectiveness of a watershed management practice.

2. Review of Relevant Literature

The concept of integrated water resource management emerged in the 1970s following warnings by the scientific community on the state of the environment. The UN Conference on Human Environment of 1972 is one of the first events that emphasized environment management in the framework of development. The conference urged governments to pay attention to the conservation of natural resources while pursuing their development goals. However, for many governments the implementation of conservation and development issues remained as separate goals for a long time. Natural resources conservation was regarded as a luxury activity and the responsibility of rich countries, while poor countries concentrated on fighting poverty, illiteracy, and diseases (FAO, 2006). It was the Brundtland report (WCED, 1987) that launched the concept of sustainable development. The WCED (ibid.) defined sustainable development as development that meets the needs of the current generation without compromising the ability of the future generation to meet their needs. The report marked the beginning of the integration of both development and conservation goals in planning.

Recently, there has been an increasing policy interest in integrated watershed management in which socioeconomic issues are given priority. Policy demands for information about the economic value of water and the economic consequences of watershed management have also increased (see, e.g., EU Commission, 2000; Brouwer & Hofkes, 2008). Scholars advance that integrated approaches to natural resources management are required to represent adequately the interrelationship between socioeconomic and biophysical processes (Jakeman & Letch, 2003; Liu et al., 2008). However, until recently most integrated catchment decision tools were restricted to single disciplinary models that focused on natural systems, with limited representation of socioeconomic processes (Brouwer & Hofkes, 2008). There is still a limited experience in developing catchment models that consider environmental change and economic values (Kragt et al., 2010).

Some scholars see the need for an integrated conservation approach that brings together upstream communities and downstream water users to reverse degrading watersheds (MEA, 2005; Pagiola, 2005; 2008; Porras et al., 2008). In this regard, they have regarded market-based incentives for conservation as the ideal policy tools for watershed conservation as opposed to command and control instruments (Pagiola et al., 2005; Locatelli & Vignola, 2009; Okurut, 2011; Khanal & Poudel, 2012). Here, it is crucial to have key empirical analyses of downstream users who are willing to pay (WTP) for the services provided to upstream land holders before establishing a downstream-upstream market link (Whittington, 2002; Locatelli & Vignola, 2009).

Also, empirical studies in different parts of the world have focused much on the determinants of WTP (see, e.g., Calderon et al., 2013; Emily et al., 2013; Chapika et al., 2009; Lokina et al., 2006; Wendimu & Bekele, 2011; Farolfi et al., 2007; and Adenike & Titus, 2009). These studies show that the determinants of WTP that influence WTP include household income, education level of the head of household, reliability of water supply, perception on the quality of water, household size, age of the head of household, distance to the source of water, and the gender of the head of households.

While there is a lot of literature on integrated watershed management with application of both command and control approaches, and recent approaches on market-based incentives, the effectiveness of these approaches to ensure sustainable watershed management has been limited. For example, Hope and Gowing (2004) argue that natural assets—such as land, forests, and water—have linkages between watershed management and livelihood, and thus watershed management that focuses on natural resources alone will have a limited impact on livelihood and poverty. However, this argument does not state clearly that established relationships are location-specific, and thus cannot be used to generalize situations in all areas. Therefore, this is what necessitates a site-specific study to establish the actual conditions of the natural environment, socioeconomic status, governance, and cultural issues to ascertain the link between watershed resources and welfare conditions of a local community.

Hence, this paper sets out to bring in a new dimension that should be considered when addressing watershed sustainability. The focus is on how stakeholders can be directly involved in conservation; while at the same time creating a sense of ownership, by the surrounding community, of the resource managed through what is referred to herein as "reconciliation between WTP and cost of conservation" of watersheds.

3. Analytical Framework and Methodology

The paper mostly made use of the prospect theory, where the loss aversion concept is central. The assumption here is that an individual is faced with two options: to take part in a conservation programme, or not. To opt for conservation, an individual expresses willingness to pay for conservation because of loss aversion. In this case, access to water services provided by a watershed is considered as a natural endowment that cannot be redeemed, in certain terms, if it is lost. Thus, an individual who is not willing to lose this access will exhibit loss aversion behaviour. That is, conservation is considered by stakeholders when it is perceived to generate better prospects in the future. In this case, individuals opt to be involve or not in a conservation programme based on the preference ordering of the prospects. The axiom of prospect preference ordering and that of selected prospect was utilized: different payoff per individual with a Von Neumann-Morgenstern (V.N-M) expected utility (Neumann & Morgenstern, 1944) were expected.

Preference ordering over decisions can only be derived from a preference ordering over associated prospects. Prospects are made from the expected outcome, and the associated probability of the outcome. A decision-maker will always prefer the prospect that gives a better chance of getting a higher-valued outcome. A decision of actual participating in the programme was associated by establishing the willingness to pay for conservation once an individual opted to take part in the conservation. The emphasize here is that individuals are solely willing to contribute after being educated on what activities are going to be done, and the respective cost of each activity. To institute this, the CVM was employed with the double-bound referendum to elicit the willingness to pay. The dichotomous CVM uses a random utility theory in which choices are assumed to be based on utility comparisons between available alternatives, and the alternative that provides the highest utility will be preferred (McFadden, 1974).

It is common to have individuals who are directly benefiting from harvesting water resource, and hence degrading it. Thus, instituting sustainable conservation would require gauging the WTP and WTA, which could be challenging. Theoretically, it has been proved that WTA is greater than WTP because of the loss aversion behaviour. Sustainability is defined when WTP is equal or greater than the cost of conservation. The WTA is related with the cost of conservation in that an individual who is harvesting watershed resource—and thus degrading it—would ask for relatively a large amount of money as compensation to forgo the degrading activities. Therefore, in this study, the cost of conservation is used as proxy for the WTA; and is estimated by directly costing the conservation activities.

3.1 WTP Model Specification

To model the WTP, this study followed Cameron's (1988) approach. The WTP for this case is derived from the following function:

$$WTP(z^0, z^1, u^0; s) = e(z^0, u^0, s) - e(z^1, u^0, s) \quad (1)$$

Where $z^1$is the situation with improved water services, z^0 is the current water supply services, s is a vector of socio-economic variables, and u^0 is the utility level before the introduction of improved water services. According to Cameron (1988), this is called the valuation function that measures the compensating surplus of value improvement.

Assuming a linear functional form for the WTP, the econometric model is:

$$WTP_i(Y_i) = x_i'\beta + \varepsilon_i \quad (2)$$

Where Y_i is the unobserved true individual willingness to pay, which is assumed to depend on individual socio-economic characteristics contained in the vector x_i. The error term ε_i is distributed with c.d.f. $\Phi(\varepsilon_i)$, with zero mean and variance equal toσ.^{2} In this model, Y_i is considered a latent continuous censored variable: the observed variable is the answer 'YES' or 'NO' to the question regarding whether or not an individual would be willing to pay a given amount t_i. It is expected that the individual will answer 'YES' when his WTP is greater than the suggested amount, which is when $WTP_i > t_i$(i.e., $Y_i > t_i$); and not willing to pay the offered amount if $WTP_i < t_i$ $(i.e., Y_i < t_i)$.

Letting P_1 be the probability that $WTP_i > t_i$ and P_0 be the complementary probability, the single-bounded model is specified as:

$$P_1 = \Pr(WTP_i > t_i) = \Pr(x_i'\beta + \varepsilon_i > t_i) = Pr(\varepsilon_i > t_i - x_i'\beta) \quad (3)$$

After standardizing by dividing through by σ, the result is:

$$P_1 = Pr(z_i > (t_i - x_i'\beta)/\sigma)) \quad (4)$$

Hence,

$$\Pr(I = 1 \mid x_i) = 1 - \Phi((t_i - x_i'\beta)/\sigma) \text{ and } \Pr(I_i = 0 \mid x_i) = (\Phi(t_i - x_i'\beta)/\sigma)$$

Where $\sigma \sim N(0,1)$ and $\Phi(x)$ is the standard cumulative normal

The likelihood function for a given sample of n independent observation is:

$$L = \prod_{i=1}^{n} \left[1 - \Phi\left(\frac{t_i - x_i'\beta}{\sigma}\right)\right]^{I_i} \left[\Phi\left(\frac{t_i - x_i'\beta}{\sigma}\right)\right]^{1-I_i} \quad (5)$$

and the log-likelihood function is:

$$LogL = \sum_{i}^{n} \left\{I_i \log\left[1 - \Phi\left(\frac{t_i - x_i'\beta}{\sigma}\right)\right] + (1 - I_i)\log\left[\Phi\left(\frac{t_i - x_i'\beta}{\sigma}\right)\right]\right\} \quad (6)$$

Where I_i is a dummy variable assuming value 1 if the answer is positive, and otherwise. Since $1/\sigma$ is the coefficient of bid t_i, and bids are varied among individuals, β and σ can be estimated separately, hence a direct estimate of the standard deviation of WTP.

3.2 WTP Information Elicitation

To elicit WTP, Hanemann et al. (1991) proved that the double-bound dichotomous CVM is asymptotically more efficient than the single-bounded method. Further, Carson et al. (1986) states that the single-bound method faces the problem as each individual provides very little information with respect to his WTP, which requires a relatively large sample to have an accurate estimation of WTP. The alternative that improves the efficiency of estimation and provides more statistical information than a single-bound method is the double-bounded dichotomous choice CVM model (Hanemann et al., 1991). The double-bounded model has four responses where two dichotomous variables are observed for each response, which provide more information, that is, answers to the first question and a follow-up question. The benefit of a follow-up question is that the analysis of such data substantially reduces the variance of the average willingness to pay estimates (Lang, 2010). This paper adopted the bivariate Probit model by Cameron and Quiggin (1994) since it alleviates apparent distortions introduced by the standard treatment of follow-up questions when respondents are offered a follow-up bid to an initial contingent valuation question (Haab, 1998). To compute the mean and median WTP, the bivariate Probit models was estimated with and without explanatory variables.

Thus, individuals were asked on their willingness to take part in the conservation programme, and consequently the amount of money one would be willing to contribute to support the conservation programme. In this case, several bids with varying amounts were used and respondents were assigned a particular bid amount to refer to when deciding on the amount to contribute. This means the level of the second bid depends on the response to the first bid. If the respondent says 'YES' to the first bid (t_i^I), s/he is presented with a second bid (t_i^H) with amount greater than (double) the first bid ($t_i^I < t_i^H$). If the individual responds with a 'NO' to the first bid, the second bid (t_i^L) is offered but this time the bid amount is smaller than (half) the first bid ($t_i^I > t_i^L$). The outcomes of this method are (i) 'YES' to both bids; (ii) 'NO' to both bids; (iii) a 'NO' followed by a 'YES'; and (iv) a 'YES' followed by a 'NO' response. The second question offered is not independent of valuation information, which the respondent has revealed in answering the first WTP question. The sequence of questions isolates the range in which the respondent's true WTP lies, placing it into four intervals: $(t_i^H, +\infty)$, $(-\infty, t_i^L)$, (t_i^L, t_i^I) or $(t_{i,}^I t_i^H)$ (Weldesilassieet al., 2009).

The second bid, in conjunction with the response to the initial preference decision, allows both upper and a lower bound to be placed on the respondent's unobservable true WTP. If the second decision is in the same direction with the first ('YES', 'YES'; 'NO', 'NO'), it raises the lower bound or lowers the upper bound, respectively. Following Hanemannet al. (1991) the probabilities of these response outcomes can be expressed as:

$$\Pr(yes, yes) = \Pr(Y_i \geq t_i^H \geq t_i^I) = 1 - \Phi(t_i^H) \quad (7)$$
$$\Pr(yes, no) = \Pr(t_i^I \leq Y_i \leq t_i^H) = \Phi(t_i^H) - \Phi(t_i^I) \quad (8)$$
$$\Pr(no, yes) = \Pr(t_i^L \leq Y_i \leq t_i^I) = \Phi(t_i^I) - \Phi(t_i^I) \quad (9)$$
$$\Pr(no, no) = \Pr(Y_i \leq t_i^L \leq t_i^I) = \Phi(t_i^I) \quad (10)$$

The likelihood function for a given sample of n independent observation for double bounded is:

$$L = \prod_{i=1}^{n} \left[\Phi\left(\frac{t_i^H - x_i'\beta}{\sigma}\right)\right]^{I_i I_i^H} \left[\Phi\left(\frac{t_i^H - x_i'\beta}{\sigma}\right) - \Phi\left(\frac{t_i^I - x_i'\beta}{\sigma}\right)\right]^{I_i(1-I_i^H)} \left[\Phi\left(\frac{t_i^I - x_i'\beta}{\sigma}\right) - \Phi\left(\frac{t_i^L - x_i'\beta}{\sigma}\right)\right]^{I_i^L(1-I_i)} \left[\Phi\left(\frac{t_i^L - x_i'\beta}{\sigma}\right)\right]^{(1-I_i)(1-I_i^L)} \quad (11)$$

The corresponding log-likelihood function for the responses to the double-bounded CV survey is written as:

$$\boldsymbol{LogL} = \sum_{i=1}^{n} \Bigg\{ (I_i I_i^H) \log\left[\Phi\left(\frac{t_I^H - x_i'\beta}{\sigma}\right)\right] + I_i(1 - I_i^H) \log\left[\Phi\left(\frac{t_i^H - x_i'\beta}{\sigma}\right) - \Phi\left(\frac{t_i^I - x_i'\beta}{\sigma}\right)\right] + I_i^L(1 - I_i) \log\left[\Phi\left(\frac{t_i^I - x_i'\beta}{\sigma}\right) - \Phi\left(\frac{t_i^L - x_i'\beta}{\sigma}\right)\right] + (1 - I_i)(1 - I_i^L) \log\left[\Phi\left(\frac{t_i^L - x_i'\beta}{\sigma}\right)\right] \Bigg\} \quad (12)$$

Where t_i^I is the bid offered in the first question; t_I^H is the follow-up if the answer to the first question has been positive; t_i^L is the follow-up when the answer to the first question has been negative; I_i, I_i^H, I_i^L are dichotomous variables with value 1 if the answer to the first bid or the corresponding follow-up has been positive, and 0 otherwise. Maximization of the log-likelihood will yield estimates of β and σ.

Once the parameters of the model are estimated through the maximum likelihood procedure, estimation of the mean and median WTP is straightforward following the Jeanty and Hitzhusen (2007) formulas. In this study, an exponential function form was assumed as in a linear form, the bid variable is linearly specified which forces mean and median WTP to be equal. However, this leads to problems in estimating mean WTP (Carson & Louviere, 2010). To get out of this, we use the formula:

$$\text{Mean WTP} = EXP\left(\frac{-\bar{X}_i'\hat{\beta}'}{\hat{\beta}_0} + \frac{1}{2}\sigma^2\right) \quad (13)$$

$$\text{Median WTP} = EXP\left(\frac{-\bar{X}_i'\hat{\beta}'}{\hat{\beta}_0}\right) \quad (14)$$

Where $\hat{\beta}_0$ is the coefficient on the bid amount, which is a point estimate of $1/\sigma$.

As result, an estimate for standard deviation of willingness of pay is given by:

$$\hat{\sigma} = -1/\hat{\beta}_0 \quad (15)$$

3.3 Estimation of Cost of Conservation

Igunga town residents depend on the Bulenya dam as their main source of water for both domestic and commercial use. The dam has a catchment area of approximately 194km^2 (Ndomba, 2013). Further, the dam is facing high sedimentation, especially during the rainy season at the rate of 0.35 percent of the dam per year (ibid.). The high sedimentation and siltation are due to soil erosion emanating from anthropogenic activities such as cultivation and livestock keeping, which affect the quality and quantity of water supplied to Igunga town residents. Therefore, for a sustained production of water, the area needs to be properly managed. The management activities for sustainability includes; (i) boundary demarcation; (ii) planting trees; (iii) conducting regular patrols; (iv) provision of regular education to the villagers around the catchment area; (v) employing labour for security; (vi) building a security office; (vii) putting posters with information about the catchment; (viii) constructing an alternative area where animals can graze and drink water; and (ix) allocating an area for miscellaneous activities.

The total cost of conservation was obtained by the summation of costs from all activities undertaken for sustainable provision of water service by the catchment area by using the following equation:

$$cost = \sum_{i=1}^{k} X_i \quad (16)$$

Where X_i represents activities that are to be implemented for a sustainable provision of water by the catchment.

4. Study Area and Data

4.1 Study Area

The data were collected in Igunga town, one of the water-stressed areas in Tanzania. The town has 28,197 people, which is 13% of the total Igunga district population of 399,727 people (URT, 2013). A purposive sampling of streets of Igunga town was done, in which households from all streets are the beneficiary of water supplied from Bulenyahill dam. A representative sample of 200 households was sampled from all 8 streets of Magharibi, Benki, Kamando, Nkokoto, Stoo, Kati, Mwayunge, and Mashariki. Sample size estimated was based on equation (17).

$$n = \frac{z^2 * P(1-P)}{\epsilon^2} \quad (17)$$

Where n = estimated minimum sample size required; z = level of confidence (1.96 for 95% confidence interval); p = expected proportion of respondents willing to pay (i.e., p = 25% for individual WTP); and ∈ = margin error.

The selection of households for the study was done to ensure representativeness, i.e., having mixed kind of households in terms of economic status, occupation, asset ownership and sources of water used. To ensure representativeness of households with different characteristics in the study, a household roaster was prepared prior to visiting the household using leaders who could classify their residents accordingly. This was done using a systematic random sampling where in each selected household, a head of the household or elder member of the household, was interviewed using a structured questionnaire.

4.2 Variables and Measurement

The dependent variable used in this study is WTP, which is a dichotomous variable with 'YES' = 1 if a household is willing to pay; and 'NO' = 0 if a household is not willing to pay from the different bids that were presented. Further, different explanatory variables are included, e.g., the initial bid amount presented to a respondent. This was measured as a continuous variable and it was expected to reduce WTP because an increase in initial bid amount implies reduction in household income, which make people tend to avoid due to income loss. Also, age of the head of household in years was collected. *A prior*, it is not possible to know how a respondent's age may impact WTP. One possible impact is that the level of knowledge about water-related problems increases with age, and this may increase their WTP. On the other hand, as one becomes old, s/he is likely to lose flow of income; and hence negatively affect WTP. Further, the marital status of the head of household was categorized into married (1) and not married (0). A married individual is expected to be more willing to pay than one who is not. This is because demand for water increase because of an increase in the number of household members.

In addition, the number of years of schooling of the head of household was also included. It is expected that WTP for improved water quality and reliability of supply is positively related to education. The longer time in formal schooling (years), the more people understand better the consequences of using unsafe water, and the need to have reliable water supply. Therefore, the educated will be more willing to pay than the illiterate. Also, the more educated a person is, the more likely is s/he to have more income and thus WTP. Also, household monthly income was included. This was expected to be positively related to WTP. The environmental economic theory assumes that the demand for an improved environmental quality increases with income. Consequently, those with a higher income are expected to be more willing to pay for an improved water quality and reliability of supply than those who have little or no source of income.

The study also includes household size. A big household size has an implication on the use of water. It is expected that household size is inversely related to WTP. It is assumed that big-sized households will be willing to pay relatively less due to the associated high running costs (due to budgetary constraints). Thus, the study expects the sign of its coefficient to be negative. Distance to the main source of water in meters is included since it has an implication on the time and other costs used to fetch water from the source. It is expected to affect positively if the program voted is likely to reduce the distance to the main source of water. On the contrary, if one lives far from the main source of water, then his/her WTP will be negative since no change in distance will be observed.

The average amount of water used by a household per day (litres) also may affect WTP. Willingness to pay is expected to increase with an increase in the quantity of water used per day. This can be done to avoid shortage of water, and hence maintain the amount used without much struggling because a household will be assured of a reliable water supply. Further, we also include waterborne diseases that at least one household member suffered in the past four (4) weeks prior to the survey (1 = 'YES', 0 = 'NO'). We expect this to have a positive or negative effect on WTP as households with a member who has suffered from waterborne diseases are worried about getting such diseases again. Therefore, their willingness to pay could be high to avoid being attacked by waterborne diseases. On the other hand, waterborne disease could negatively affect WTP as people would have less trust with the quality of water used, and thus switch to alternative sources. The number of years of a household head has stayed in Igunga town (experience) was another variable used. This increases WTP as a head of household who had stayed for a long time tends to be aware of the problem, and hence be more willing to pay. Also, this person might have established permanent residence, unlike those who are in the town on a temporary basis.

Another variable was ownership of house by household head (1 = 'YES', 0 = 'NO'). This is expected to positively affect WTP since a person who has established permanent residence and owns a house in the town will be more willing to pay to have improved water services for her/his lifetime, unlike those who do not own a house. Further, the gender of the head of household (1 = male, 0 = female), was another measurement. The WTP could be affected positively if females had control of finances as they know the costs of poor water supply. However, since in many cases the male head of household has control of finances, this could have a negative effect on WT. Price charged per 20 litres bucket of water was also another variable. According to the economic theory, the higher price of water implies lower WTP as there will be more income used to pay for water and therefore people would be less willing to pay more as the price increase. Table 1 presents the definition of the variables with their expected sign and measurement.

Table 1: Variable definition and their expected signs

Variable	Description	Expected Sign
bid1	initial bid amount in TZS presented to respondent	-
headage	Age of the head of household	+/-
married	Marital status (1=married; 0=Not married)	+
headeduc	Number of years of schooling by the head of household	+
hhincome	Average household income in TZS per month	+
hhsize	Total number of household members	-
distance	Distance to the main source of water in metres	+/-
quantitywater	Average amount of water uses by household per day in litres	+
waterborne	Waterborne diseases suffered (1 = yes, 0=no)	+
experience	Number of years has stayed in Igunga town	+
houseownership	ownership of house by household head (1= yes, 0=no)	+
male_head	Gender of the head of household (1 =male, 0=female)	+/-
price/20L	Price in TZS charged per 20 litres buckets of water	-

5. Results

5.1 Descriptive Statistics

Table 2 presents the descriptive statistics. The table shows that the average age of the head of household is 41 years, and that most (74%) household are male-headed; which is typical of most African societies. In addition, the study findings show that the average number of years spent schooling by head of households is 8 years, which implies that most of the sampled household had a primary level of education. Also, the household size was found to be 4.9 people per household; 47% of the surveyed households resides in their own house; while the average household monthly income was TZS324,600. The average distance from home to the source of water is approximately 360m, and on average a household uses 100 litres of water per day. Table 2 shows details about the descriptive statistics.

Table 2: Summary Statistics for Some Selected Variables

Variable	Observation	Mean	Std. dev.	Min	Max
bid1	200	2980	1449.17	1000	5000
hheadage	200	41.21	12.82	19	85
hheadsex	200	0.74	0.44	0	1
hheadmarital	200	0.72	0.45	0	1
hheadeduc	200	8.60	3.59	0	18
hhincome	200	324642	361647	80616	4595667
hhsize	200	4.99	2.14	1	15
distancewatersource	200	363.12	375.48	20	2000
quantitywater	200	110.97	59.06	20	480
houseownership	200	0.47	0.50	0	1
waterborne	200	0.22	0.41	0	1
price/20L	200	92.16	62.98	30	300
experience	200	22.15	16.12	0	85

Source: Author computation from survey data, 2014

5.2 Estimation of WTP

Table 3 presents estimation of monthly mean and median WTP by the probit model for four different methods. The results shows that estimated mean WTP is higher compared to median WTP across all the methods used. To know what would happen in the referendum, the median WTP is a more relevant measure. Also, it tells that 50% of the population has a WTP that is equal to the median. This measure is also much less sensitive to extreme values. Due to these reasons, the median WTP value was used.

Table 3: Estimated Mean and Median WTP

Method	Mean WTP	Median WTP
Single-bounded with bid as the only covariates	8421.25	4830.33
Single-bounded with other covariates	7517.32	4925.56
Double-bounded with bid as the only covariates	8276.89	4799.43
Double-bounded with other covariates	7939.80	5030.56

Note: Exchange rate: 1 USD = TZS1,653
Source: Authors computation from Survey data, 2014

5.3 Aggregation of the WTP Values

According to Hanemann et al. (1991), one of the main objectives of estimating an empirical WTP model based on the contingent valuation survey response is to derive a central value of the WTP distribution. In this study, the amount that households are willing to pay for improved water services by conserving the catchment area was measured. The mean WTP for the single-bounded was TZS8,420 without explanatory variables, and TZS7,520 with explanatory variables. The mean WTP for the double-bounded was TZS8,280 and TZS7,940 without and with explanatory variables, respectively. Also, for single-bounded, the median was about TZS4,830 without explanatory variables, and TZS4,920 with explanatory variables. For the double-bounded the median was about TZS4,800 without explanatory variables, and TZS5,030 with explanatory variables (Table 3). For the reason stated in section 5.2, the median WTP is used as it is a more relevant measure.

Four different values for the median WTP (two from both single- and the other two from double-bounded elicitation methods) were obtained, and these values were weighted to obtain a single median value. The criteria for weighting the median value were based on the advantages of the double-bounded method over single-bounded method. In this paper, its assumed weights 0.1, 0.2, 0.3 and 0.4 are as indicated in Table 4. The weighted median WTP is TZS4,920. Finally, the four values of WTP were aggregated to get WTP by multiplying the weighted median WTP with the total number of households (i.e., 4,406 households).[1] These translate to a total WTP of about TZS21.6m per month.

Table 4: Median WTP Results and Weighted Median WTP

Method	Median WTP value (TZS)	Weight Value	Weighted WTP value (TZS)
Single bounded with bid as the only covariates	4830	0.1	483
Single bounded with other covariates	4920	0.2	984
Double bounded with bid as the only covariates	4800	0.3	1440
Double bounded with other covariates	5030	0.4	2012
Total weighted value		1.0	4919

Notes: Weighted WTP values are obtained by multiplying median WTP value and weight value
Exchange rate: 1 USD= 1,653 TZS
Source: Authors computation from Survey data, 2014

5.4 Results on Cost for Conservation of the Watershed

The estimated cost is equivalent to TZS1.2m/km^2 per annum (see Table 5) as the total area of the catchment area is 194km^2 (Ndomba, 2013). Activities such as boundary demarcation and fencing, putting posts, area for animal feeding and drinking water, security guard office, and construction of toilets are done once for all. Therefore, the costs for conservation of the catchment area will decrease overtime.

[1]The number of households was calculated based on the 2012 National Population Census, which estimated that Igunga town had a total population of 28,197, people with an average household size of 6.4

Table 5: Estimated Cost for Catchment Area Conservation and Management

Activity	Cost per Annum (TZS/km^2)	% of Total Cost
Boundary demarcation and fencing*	515,464	42.83
Planting (trees & grasses)	30,928	2.57
Putting Posts*	12,887	1.07
Establishing an area with water for animal drinking*	257,732	21.41
Area for animal feeding*	257,732	21.41
Guards office and toilets*	25,773	2.14
Education	6,186	0.51
Patrol	15,464	1.28
Security guard	77,320	6.42
Miscellaneous expenses	4,124	0.34
Grand total	**1,203,608**	**100.00**

Note: * indicate activities that are done once for all

Exchange rate: US$ = TZS1,653

Source: IGUWASA Water Board, 2013.

5.5 Linking Cost of Conservation and WTP

The total WTP for improved water services in Igunga town is TZS21.6m per month. This is equivalent to WTP of TZS260m per annum. It is important to note that the amount of money that can be collected from households per month is substantial, and covers the cost of conservation in a year (i.e., TZS233m per annum for the entire watershed[2]). Some amount of income that is collected can be invested in other income-generating activities that reduce much dependence on catchment area such as sustainable fishing and modern agriculture through the use of improved inputs such as seeds and fertilizers, which improve crop productivity to reduce the pressure of farmers on the encroachment of the catchment area.

5.6 Determinants of WTP

To determine the factors that influence WTP, we estimated the Probit model. We estimated the model using both socioeconomic and environmental-related attributes. These include initial bids, household monthly income, education level of head of household, waterborne diseases (whether any household member had suffered from waterborne diseases or not), house ownership (whether the head of household own a house or not), and Price/20L (amount paid for water per a 20-litre bucket). These were the factors hypothesized in this paper to influence household willingness to pay for conservation. Table 6 shows the results for the determinants of WTP. The results indicate that initial bid, household income, household head education, waterborne diseases, and house ownership significantly affect WTP for the conservation of watersheds.

[2]The cost of conservation was obtained by multiplying the cost per annum per km2 within the entire watershed area of 194km2.

Table 6: Probit Estimation Results on Willingness to Pay

Variables	**Coefficients**
bid1	-0.0004***
	(0.0001)
hhincome	0.4571*
	(0.2722)
hhsize	0.0554
	(0.0734)
hheadage	-0.0049
	(0.1120)
hheadmarital	0.2128
	(0.3770)
hheadeduc	0.0747**
	(0.0377)
distancewatersource	-0.0005
	(0.0003)
waterborne	-0.1053**
	(0.0500)
quantitywater	0.0028
	(0.0029)
experience	-0.0003
	(0.0084)
houseownership	-0.5423**
	(0.2488)
price/20L	-0.0042**
	(0.0017)
hheadsex	-0.2507
	(0.3841)
constant	-3.8169
	(3.0968)
Observations	200

Note: Standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1

6. Discussion

As expected, the response 'YES' to the WTP question is significantly related to the bid amount at 1% level of significance. The negative sign indicates that as the bid amount increases, a respondent would be less likely to pay for improved water. From the law of demand, the higher the price the low the demand; and in this setting WTP imply demand for the resource and bid amount is the price to be paid. The coefficient on household head's level of education is statistically significant at 5% level. As more people understand better the consequences of using unsafe water and the need to have reliable water supply, the more they will be willing to pay for conservation. Also, the more educated a person is, the more likely is s/he to have more income and thus more WTP. These results are similar to the findings by Wendimu and Bekele (2011), Lokina et al. (2006), Chapika et al. (2009) and Ndetewio et al. (2013). Also, the coefficient on household monthly income level is positive and statistically significant at 10% level. This implies that WTP increases with increase in the level of income of a household. The environmental economic theory assumes that the demand for an improved environmental quality increases with income. Consequently, those with a higher income are expected to be more willing to pay for an improved water quality and reliability of supply than those who have little or no source of income. This is consistent with results obtained in other studies by Wendimu and Bekele (2011), Lokina et al. (2006), Farolfi et al. (2007), and Ndetewio et al. (2013).

Regarding waterborne diseases, the results show that the coefficient of households that had at least one household member who had suffered waterborne disease is negative and significant at 5% level. Contrary to the expected positive sign, the variable turns to be negative. This emanates from the survey data, which show that, of the correspondents, 21% reported to suffer from diarrhoea; 16% from dysentery; 5% from cholera, and 58% from typhoid. This experience may have built negative attitudes about the water supplied by the Igunga Water Supply Authority (IGUWASA), leading to 16% of the respondent to use other source of water—e.g., rainwater, well water, river water, etc.—for household use.

The coefficient of house ownership is negative and significant at 5% level. This was expected to be positive as households that own houses would need to have permanent water supply for use. Unfortunately, the sign was negative and significant, and this could be attributed to household heads who own houses switching to other alternative source of water other than from IGUWASA. As we saw earlier, 16% of the respondents depend on rain water, buy water from other source, or have their own private water wells. Also, the price of water per 20-litre bucket (price/20L) supplied by IGUWASA is statistically significant at 5% level. This was as expected, as the price of water increase might lower people's willingness to pay for improved water services. Therefore, a negative sign indicates that if the existing price is high, it reduces people's demand and hence their WTP for improved water services will be low. Variables such as household size, age of the head of households, marital status, gender of the head of households, quantity of water experience have no significant influence on WTP for improved water services. This is consistent to findings by Adenike and Titus (2009).

7. Policy Implications

This study provides an innovation on how to ensure effective management of watershed resources. Such innovation is one that is based on reconciling the WTP and conservation costs. In this study, a careful design of the WTP for conservation of the source of water in Igunga district was done to link the WTP and cost of conservation, unlike in most existing cases of watershed management schemes found in literature. The inclusion of conservation costs facilitates resource ownership to stakeholders, brings sharply on board all actors to one common goal, and enhances the effectiveness of watershed management practice. The key findings of the study are that WTP results into sustainable funding when stakeholders are well-informed about the type of management and associated costs of conservation. In addition, the study found that, on average households are willing to pay for the conservation of water catchments; and that factors influencing WTP include household income, education level, house ownership, price of water, and the outbreak of waterborne diseases. Increase in income and education were found to influence positively households' WTP for conservation. The implication from the study findings is that effective conservation of watershed in the study area would require, to large extent, community participation. Policies geared towards improving household income and education access would benefit further water resources management in the area.

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