Estimating the Willingness to Pay for Improved Water Service in Tanzania

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Abstract

Willingness to pay is a stated preference concept in the theory of consumer behaviour that aims to determine the amount of money a consumer will pay for the supply of a good or service in the absence of a market mechanism. It is a concept applied to many research studies worldwide, and in developing countries in particular, revealing very high levels of willingness to pay for water. This article analyses the willingness to pay for improved water service for domestic and irrigation use in the rural setting. We use household data from a survey conducted in the Rufiji water basin. We used both qualitative and quantitative analysis. The results from the non-parametric estimates suggests that, on the average, households in the low bound category are willing to pay approximately Tsh17,000 per annum for water environmental services, which is about Tsh1417 per month (approximately US$1.12). This is approximately half of what they are currently paying. On the other hand, the upper bound category would pay about Tsh47,500 per annum, which is approximately Tsh3,958 (3.14 US$) per month. This is slightly higher by 32% than what they are currently paying for domestic water use. Econometric analysis suggests that income of the household, age, education, and conservation activities within villages explains households' willingness to pay for water improvement.

Introduction

Willingness to pay is an economic concept which aims to determine the amount of money a consumer will pay for the supply of water. It is a concept applied to many research studies worldwide, revealing very high levels of willing to pay for water in developing countries. The revenues generated through the purchase of water have been shown to equate to the cost of developing a city's public water utility. This has been an important revelation for water planning managers in developing countries where urbanization is increasing rapidly, and the demand for water is growing faster than the existing weak infrastructure can meet. Clearly, willingness to pay (WTP) has a role in assessing acceptable water charges to users, upon which water policy can be developed with confidence of achieving cost recovery.

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However, charging for water attracts debate: how should water be priced? Water is many things to many people: a gift from God, a basic need, the basis of a national development and economic security, an environmental resource, a commodity, etc. Hence to value water is controversial. The variations in perceptions of water are clearly wide ranging, and it cannot be assumed that people attach the same value or cost for the provision of water at any one time in any one place. These variations are not always recognized by governments, organizations, or development agencies that tend to over- or under-estimate the levels of WTP by a community when implementing water projects. Consequently, water supply projects fails as the needs and requirements of the community have not been met, and their unwillingness to pay is clearly signalled. Individuals are unwilling to pay such services. As a result, agencies (government and non-government) are unable to recover their capital costs; thus becoming more reluctant and less financially able to provide further water services.

In the absence of access to a public or private water supply system, individuals can either access water as a basic existence need through purchase from the informal sector (more common in urban areas), whilst more rural locations have the alternative option of accessing groundwater. Both these options indicate the state's lack of capacity to develop the water infrastructure to provide its population with water on an equitable basis. In addition, it is an indication of the lack of institutional control over local water usage, which has implication for the sustainability of the scarce environmental resource.

Whittington's research in the area of WTP is the most prolific. He describes a study from Onitsha, Nigeria (1987) which illustrates how levels of payment for water equate to the financing of urban water supply infrastructure development. He argues that little is known about household behaviour in securing water for domestic purposes, and how much they are willing to pay for improved services. Major development agencies such as the World Bank (1997) promote the pricing of water as a means for public water utilities to manage the allocation of existing water supplies more effectively. Therefore, it supports that economic concept of willingness to pay for water (1992). The Banks' approach to estimating levels of WTP is by application of the 5% rule. This rule commonly assumes that there is an elastic demand for the purchase of water with a cost of less than 5% of a household's income; and inelastic demand where the cost exceeds 5% of the household's income. Winpenny (1994) criticizes such a broad approach of assessing levels of WTP, not least because it does not allow for the varying values of water through space and time. Rogerson (1996) agrees with Winpenny by stating that development agencies tend to overestimate the amount individuals are willing to pay, whilst government agencies tend to underestimate the cost. Consequently, Rogerson (1996) advocates further research, at the household level to assess levels of WTP more accurately.

In contrast to treating water as an economic good, however, Schur (1993) argues that the issue of water supply is between providing water as a basic need whilst also protecting it as a scarce resource. As a basic need, Schur (1994) believes it is the states' responsibility to ensure all citizens have access to sufficient water supplies and sanitation facilities. Vira (1997) refers to it as matter of entitlement. As a scarce environmental resource, Schur's statement is in accord with the principles agreed at the 1992 Earth Summit held in Rio de Janeiro, where it was agreed that global water resources are to be protected in the interests of sustainable development. Therefore, water is to be treated as an environmental resource rather than a public or private good, and is to be protected for long-term collective consumption.

Lack of access to safe water is at the heart of the poverty trap, especially for women and children, who suffer in terms of illness, drudgery in drawing of water, and lost opportunities because of the time that drawing of water consumes. In rural Africa, according to the World Bank, 40 million hours are spent each year in collecting water for domestic use, and half of Africa's population is without access to safe water (Black, 1998). Recent renewed focus on poverty alleviation has resulted in increased attention to the benefits of improved water accessibility. Poverty assessment research has consistently shown that improvement in water services is a critical element in designing and implementing effective strategies for poverty alleviation. One of the millennium development goals (MDG) target is to halve the proportion of people without sustainable access to safe drinking water and basic sanitations by 2015.

The experience in Tanzania with respect to rural water improvement has, in general, been unmitigated disaster. Water provision facilities have invariably fallen into disuse or disrepair because the approach used to run them failed to ensure sustainability. Reports from the Ministry of Water (MoW) (1997) showed that only 40% of the population had access to clean and safe water. Between 1965 and 1985, the government spent a substantial amount of money in developing rural-based water projects to alleviate the water supply problem, but without notable success. The government, in collaboration with NGOs, is currently trying to revive many of these projects. The government is providing technical assistance, while NGOs supply initial capital requirements, overhead costs, and supervision in design and implementation. When the utility is operational, the beneficiaries (i.e., villagers) either pay for the water from the utility or contribute an annual water fee, both of which are added to the village water fund. It is anticipated that the size of the village water fund will be sufficient to operate and expand water utilities, based on market forces. To attain such sustainability, the existence of efficient water markets is essential. Sufficient fund have to be generated to meet both overheads costs and investment requirements. Information on WTP for required improvements provides an indicator of the potential capability of communities generating funds for such purposes.

This study addresses the economics of water resource development, generally, and watershed management, specifically. It seeks to determine what local people are willing to pay for improved performance of portable water and irrigation systems, particularly in the case of improved performance that would result from watershed conservation. In Tanzania, like in many other developing countries, the quantity and quality of water supplies are often inadequate in both urban and rural areas. Water systems are often plagued by poor planning, which reflects erroneous assumptions about the needs and demands of rural populations. In most cases there are no markets for water resources in many areas, and therefore no ways for evaluating costs and benefits of improved performance. Even where markets exist, as in Tanzania, prices are distorted by subsidies and other policies. It is expected that positive WTP indicates potential community ability to recover operation and management costs (Altfa et al., 1992). Thus WTP can be used to help ascertain the potential for fulfilling sustainability; at least from a financial viewpoint. A major objective of the study is to find out if communities studied were willing to pay an increased user fee or tariff for improving and expanding existing water services; and if willing, how much could be added to the current user fee or tariff to achieve the required improvement?

The Rufiji River Basin

The Rufiji Basin is the largest in East Africa, covering an area of 177,420 km^2 (about 20% of Tanzania) and is one of the nine river basins in the country. It is situated between longitudes 33°55'E and 39°25'E, and between latitudes 5°35'S and 10°45'S. The altitude of the basin rises from 0m at the Indian Ocean to above 3,000m above mean sea level (mamsl) in the highlands, The basin extends inland, from the Indian Ocean, for about 640km and its width varies from a minimum of about 55km in the lower parts to about 480 km in the portion above Iringa. The Rufiji river originates from the Southern Highlands of Mbeya, Ruvuma, and Iringa where the Great Ruaha River, the most important catchments, and the famous Usangu wetland are found. It also comprises three distinct major river systems: the Great Ruaha; the Kilombero; and the Luwegu. In its totality, the basin contains large areas of agricultural land, hydropower, fisheries, and forestry on which communities' livelihood activities depend.

The importance of Usangu catchment cannot be overemphasized. Although it comprises only 12% of the total Rufiji catchment area, it provides 56% of runoff to Mtera reservoir through the Ruaha River (URT, 2000). Since 1993, the Ruaha has been drying up in the National Park, with the dry period progressively increasing. The impact of this on the wildlife, and particularly the aquatic fauna, has been severe. This has threatened tourism potential, irrigation farming, and electricity supply for the country. In Morogoro region, the large Kibasila swamp, alongside the Kilombero River, is an important wetland, which is increasingly being utilised for agriculture. In Kilombero district, the Kilombero river joins the Ruaha to form the Rufiji river, which goes on to drain into the Indian Ocean.

Water in the basin is mainly for domestic, industrial, agricultural, livestock and wildlife uses. Irrigation farming is by far the greatest economic activity utilising the waters of the basin. This takes place in both the Usangu catchments, and the Kilombero valley. An area of about 38,260 hectares was under irrigation farming of rice and sugarcane (in Kilombero), using roughly about 600mm and 1200mm of water per season respectively in 1995. This is roughly a 20% utilisation efficiency level.[1] In 1995, a total of 482,800 hectares of potentially irrigable land was available, which would require a total of 12,192 million cubic metres when the intended 40% irrigation efficiency is applied (URT, 1995). The Rufiji basin—and most of the country—has experienced a shortage of rainfall resulting into widespread shortage of water for various uses, including hydropower generation. This has had a devastating impact on the economy by constraining power supply and forcing power rationing on all users. As a result, power production cost has gone up due to using oil for thermal generation of electric power.

The population of the basin has grown from 825,000 in 1957 to more than 3,055,051 in 2002 (URT, 2002). This high growth rate of the population in the area could be attributed to the development activities in the Basin such as irrigation agriculture and pastoralism, and of course the expanding urban populations.

Major agricultural crops cultivated include maize, beans, and peas. Potatoes, barley, and wheat are grown in the highlands; while at lower elevations some land is under pasture and rice farming. In addition to subsistence crops, small holders are increasingly turning to production of vegetables (e.g., onions and cabbage) for local markets, while large farms are moving into export-oriented floriculture, which requires irrigation. Most households combine income from agriculture with off-farm employment as construction workers in urban areas, and as labourers on bigger tea or pyrethrum plantations.

The declining quality and diminishing reliability of water supplies for household and agricultural and industrial uses resulting from deforestation, land degradation, and erosion of the upper reaches of the drainage basin is an issue of serious concern to local people, most of whom depend on untreated mountain springs for drinking water. Deterioration of the water supplies is rooted in institutional as well as environmental changes.

[1] Inefficiencies arise due to greater water abstractions than irrigation requirements due to leaving open the channel inlet gates for longer than necessary, field to field transfer of water through fields where water is not required at particular periods, poor leveling of particularly large fields and hence the canal leads to poor water management.

This study intends to answer the following key questions: (i) Are rural households in developing countries willing to pay more for improvements in the quality and reliability of water supplies? (ii) What are the key social and economic determinants for such willingness?

Valuation methods based on welfare economics theory

The facts that demand curves can be of help for estimating the WTP for a product suggests that it is fairly straightforward to assess the economic value associated with goods and services that are subject to trade at a market. However, this is of limited use when dealing with ecosystem services, which in many cases contribute to human well-being without being traded at any market. It is a major methodological challenge to be able to find out economic values associated with such non-market goods and services. Fortunately, economists have developed methodologies for evaluating natural resources in the absence of price signals. These methods call for respondents to participate in simulated transactions in a hypothetical market setting. These transactions reveal what people are willing to pay for non-market goods and services provided by the natural environment. These methods can be divided into *revealed preferences (RP) methods* and *stated preferences (SP) methods*. Freeman (2003), Garrod and Willis (1999), and Perman et al. (2003) provide useful examples of these methods.

The most used SP method so far is the *contingent valuation method* (CVM). A typical CVM application involves a description of an environmental improvement communicated to a sample of individuals, followed by questions about respondents' WTP for a realization of the improvement. Contingent valuation questions begin with the outlining of a scenario. The scenario provides the respondent with a clear description of the 'good' he is going to be asked to value. Following the scenario, the respondent is presented with a policy or project that will be undertaken to ensure that the respondent receives that good. The policy description will also include the description of a payment vehicle, through which the respondent will be expected to pay for the policy. Good contingent valuation designs involve creating realistic and practical scenarios and guidelines that can be clearly understood by respondents.

The hypothetical nature of CVM implies a possibility to estimate potential economic values associated with non-use of the environment, such as the well-being derived from the mere knowledge of the existence of an environmental resource. CVM focuses on the valuation of a scenario, describing a particular change in environmental quantity or quality, and the results provide information on preferences for the whole scenario. This allows for increased flexibility in the analysis. This study is interested in the changes of the environmental quantity and quality, and in particular water environmental resources, and therefore employs the method that will bring that scenario to the respondents which is the CVM approach.

number of studies in Tanzania which have attempted to provide a value of water analysis. These include studies by Kulindwa (2004), Kulindwa et al. (2006), ERB (2006), Turpie et al. (2003), Kashaigili et al. (2005), Mutabazi et al. (2005), and Kaliba et al. (2003). Kulindwa's studies investigated the value of water through willingness to pay for water environmental services in Pangani basin using CVM methodology. Also CVM was used for the study in Mara Wetland valuation which included water use. Turpie's study investigated the value of water in the Pangani Basin so as to put the right price of water, and to facilitate policy. The study by Kaliba investigated the willingness to pay in order to improve water supply in rural areas of central Tanzania.

Commonly used methods of estimating the value of water include the value measures based on the substitutability that can be expressed either in terms of someone's willingness to pay (WTP) for beneficial changes, or willingness to accept compensation (WTA) for adverse changes. WTP and WTA, the fundamental economic measures of value, can be defined in terms of any other commodity the individual is willing to replace with the one being valued. Although money is usually used as the indicator in which trade-off ratios are expressed, WTP and WTA can also be measured in terms of any other goods that matters to the individual. Other methods are change in net income approach, and value added to national income (GDP).

There are three different approaches that can be used to measure household WTP for environmental water resource. The first involves directly asking households to specify their costs for various types of water shortages (see, for example, Wacker et al., 1985; Doane et al., 1988a; SINTEF, 2003). The second is to study the actual behaviour of households in terms of investments aiming at mitigating water shortages. The third is to either directly or indirectly ask households about their WTP to avoid water shortages by using a stated preference approach (see e.g. Beenstock et al., 1998; Doane et al., 1988b; Layton and Moeltner, 2004, Carlsson & Martinsson, 2004). There are clearly pros and cons of either asking for the costs of water shortages or of avoiding water shortages, or of asking for the WTP of avoiding water shortages. The main difference between the approaches is that it is only the latter that considers all welfare effects by including non-market effects. For example, individuals may not be able to devote their time in other income generating activities; instead they spend a number of hours searching for water. While these negative effects do not have direct monetary effects, they clearly impact on people's welfare. An example of direct monetary effects would be for those who might decide to drill bore holes.

It is cognitively more demanding for respondents to state the welfare effects in terms of WTP rather than reporting the actual monetary cost caused by water shortages, or resource degradation. Since we expected that a large impact on households' welfare from water related problem relates to non-market effects, we applied a contingent valuation survey. In a contingent valuation survey -- which is the most commonly applied of the stated preference methods—each respondent was asked about his/her WTP for a certain scenario. There are several ways in which questions about respondents' WTP can be posed, here we only distinguished between open-ended and closed-ended formats. With an open-ended format, respondents are asked to state their maximum WTP, while with a closed-ended format, respondents answer whether or not their WTP is equal to or higher than a certain proposed bid. There are pros and cons of both these formats, and in this study we chose to use both options. The closed ended format was based on the fact that some of the households were then paying water service for both irrigation and domestic purposes. So we found it more intuitive to ask them their willingness to pay over and above the current rate. In this case, we avoided the introduction of a bid for each scenario since the starting point was already there. Other reasons for choosing an open-ended format were that the informational content of each response is higher compared with a closed-ended format, and we avoided respondents anchoring their answers on a certain bid level (Carlsson & Martinsson, 2004).

In this study, rural and urban households and irrigators were asked to state their willingness to pay for improvements in the quantity, quality, and reliability of water supplies in the face of dwindling water flows. The identified samples of water users for large and small-scale irrigator were surveyed. These were identified through the consultation with the water officer at the Rufiji Basin Water Office at Iringa. Private large-scale irrigators were covered. We consulted urban water supply and sanitation authorities and sampled domestic consumers in the entire Rufiji Basin of the Eastern arc mountains area. The idea here was to quantify individual WTP measures for adequate and reliable water supply by using contingent valuation methods (CVM). Such measures are important for policy makers when determining public investments and policy instruments in order to regulate water usage.

Sample Selection Data Collection

Household samples were selected through stratification of the village communities into occupational activities and their wealth standing. Then, within these categories, we did random sampling to obtain the representative sample of the communities in question. The main occupational groups were farmers and livestock keepers. Other groups such as civil servants were not considered separately since these would constitute an insignificant proportion of the population. Traders were also not considered separately because in most cases you would find farmers also running small business.

The household survey respondents were selected from villages within the basin areas including the Udzungwa Mountain ranges. The questionnaires consisted of a section inquiring about habits of using the water from the Basin, a section inquiring about socio-economic and demographic characteristics, and a section eliciting the willingness to pay. Apart from the structured questionnaire, we conducted a checklist of questions and focus group discussions with key informants to get the general feeling of the situation from a broad perspective. The valuation questions were preceded by participation questions forming the background and description of the good to be paid for.

Respondents in the survey were asked to state their willingness to pay for reliable and/or improved water services, both in quality terms and volume-wise. The respondents were explicitly told that for each valuation question they should answer if they were willing to pay twice or more the amount they were paying for irrigation and domestic use. If a respondent was not willing to pay twice, s/he was then asked to state his/her willingness the amount s/he was willing to pay to avoid water shortage for both irrigation and domestic water.

The survey also elicited data on household demographic composition and social-economic status, labour availability and wages, income from agricultural or non-agricultural activities, prices of outputs and inputs, access to credit, and social capital (measured by participation in community meetings). In addition, the survey contained referendum-style CV questions in which improvements in the local water system and a stipulated price were proposed to respondents, who were asked either to accept or to reject the proposal. Using the responses to the CV questions, as well as other survey data, we did an econometric estimation of a model in which WTP for water quantity and quality improvements was the dependent variable, and household earnings and proportion of income from off-farm employment were the independent variables.

The study covered 20 villages in the Rufiji basin, i.e., in Iringa (3 districts), Mbeya (1 district), Morogoro (2 districts) and Coast Region (1 districts). Iringa and Morogoro regions constituted the largest coverage due to their importance in the Rufiji water basin. During the study the Rufiji Basin Water Office was instrumental in the selection of the villages due to its central position and role in water resource management in the basin. Around 40 households were interviewed from each of the 20 villages, making a total sample of 811 households. The sampling procedure followed a stratified random sampling, where different categories (such as farmers, rich, poor, etc.,) of the people in the villages were sampled for interviews. We held a focused group meeting prior to the interview to get a general understanding of the village setting that guided the team in the sampling. Table 1 presents summary statistics of some of the variables used in the analysis.

Non-Parametric specification for WTP Estimation

The estimation of WTP levels followed the equation below after Georgiou *et al* (1997):

Aggregate $WTP_a = \sum_i [(\theta_i) \, x \, (\eta_j) \, x \, (\theta_{i\,wtp} x \, WU_a)]$ ……………………(1)

Where:

WTP_a = Willingness to pay for water environmental services per annum.

θ_i = group i's percentage of the sample and i = 1,2,3 groups.

η_j = Sample water users of the area j.

$\theta_{i\,wtp}$ = Amount of money group i is willing to pay for a litre of water as environmental services fee.

WU_a = Household's water use per annum.

D = Aggregate water users in the basin

Econometrics Specification for the Determinants of WTP

There are a number of econometric challenges when analyzing the responses. First, for each valuation question, there were a number of "zero" responses, i.e., respondents stating a zero WTP. We treated these responses as true zeros since we could not rule out a WTP equal to zero. Although the characteristics of water shortages vary, it is likely that there would be cross-sectional heterogeneity. For example, an individual who has a relatively high WTP for a short period of water shortages compared with others is also likely to have a relatively high WTP for a longer period of water shortages. Similarly, an individual with a zero WTP for a certain water shortage is more likely to have a zero WTP for another shortage. To consider both zero WTP and cross-sectional heterogeneity, we applied the following general censored model:

$$WTP_{ij}^{*} = \alpha_i + \gamma x_i + \varepsilon_{ij}; \varepsilon_{ij} \approx \mathrm{N}\left[0, \sigma^2\right]$$

$$WTP_{ij} = \max\left\{0, WTP_{ij}^{*}\right\},$$

Where

WTP_{ij}^{*} = the latent value of individual

$i's$ = WTP in treatment j,

x_i = a vector of socio-economic characteristics, and

WTP_{ij} = the observed value of individual $i's$ WTP.

By including the socio-economic characteristics in the WTP function, we allow for observed heterogeneity in WTP.

Empirical Findings

Sample Descriptive Statistics and Characteristics

Table 1 presents descriptive inferences for the variables used for this study. In general most of the variables seem to be good or accurate representatives of the population in the areas of study. At 95% Confidence Interval the sample mean is shown to be within reasonable range of the population mean under normal distribution. This result allows us to use them for detailed analysis.

Table 1 Descriptive Statistics of the variables used

Var. name	Description	Mean	Std. Dev.	Std error	95% C.I.
Sex	=1 male, 0, otherwise	0.77	0.42	0.01	0.03
Age	Log of the age of the household head	42.6	13.0	0.46	0.89
Education	=1 if the head ever attended school	0.90	0.30	0.01	0.02
Marital status	=1 if the head of household is married, 0 otherwise	0.79	0.41	0.01	0.03
Farmer	=1 if the household head is a farmer, 0 otherwise	0.873	0.33	0.01	0.02
Birthplace	=1 if the head of household is born and grown within the same ward, 0 otherwise	0.9	0.32	0.01	0.02
Buss.income	income from business	562,107	113,917	3,997.	7794.3
Mbeya	=1 if is Mbeya region, 0 otherwise	0.12	0.33	0.01	0.02
Morogoro	=1 if is Morogoro, 0 otherwise	0.52	0.50	0.02	0.03
Coast Region	=1 if is *Coast Region*, 0 otherwise	0.11	0.31	0.01	0.02
Iringa	=1 if is Iringa Region, 0, otherwise			0.00	0.00
Religion	= 1 for Muslims, 0 otherwise	0.37	0.48	0.02	0.03
Lnacreage	Log of acres owned by the household	1.02	0.72	0.03	0.05
Agric.income	Income from agricultural activities	439,475.6	31,534	1,106.5	2157.6
Wage income	Income from wages-employed	79,117.65	67,855.98	2380.91	4642.8
Transfer	Household income from relatives and others	21,916.8	56,651.3	1987.76	3876.1
Water	=1 if the household pay for water service	0.51	0.50	0.02	0.03
Conserve	=1 if the household is aware of any conservation activities within the village, 0, otherwise	0.45	0.55	0.02	0.04
Capacity	=1 if the household think that the forestry department is capable for protecting the water sources, 0, otherwise	0.366	0.482	0.02	0.03
MWTP	Maximum willingness to pay	29,602.7	22,141	776.88	1514.9
IWTP	=1 if individual is willing to pay for irrigation water, 0, otherwise	0.47	0.35	0.01	0.02
DWTP	=1 if individual is willing to pay for domestic water use, 0 otherwise	0.777	0.417	0.01	0.03
Lnmaize	Log of acre used for maize	0.313	0.544	0.02	0.04

Note: To avoid dummy variable trap, Iringa is a reference category.

Table 1 further shows that a majority of respondents were males, and this should not be a surprise as the target was household heads, reflecting that majority of the households were male-headed. The average age of respondents was 42 years, implying a middle-aged community with able-bodied bread winners. The education status suggests that majority of the respondents (about 90%) had at least attended some kind of school, of which the majority attended primary education. Also, a majority of the respondents were born within the same villages or ward. As should be expected, a majority of the respondents got a substantial part of their income from agricultural activities: about 98% were involved in agricultural activities. Surprisingly, however, about 74% of the sample were also involved in other business activities; earning slightly above what they got from agricultural activities. The annual agricultural income was slightly less than Tsh500,000. A less significant income source was a wage earner, which was approximately 8% of the sample. There was also income from transfers, earning an average of Tsh80,000 per year. More than half of the sample paid for domestic water use. In almost half of the areas payment for water was not done due to the lack of formal payment system for irrigation water; or lack of infrastructure for domestic water supply.

Results for Domestic Water Use

A key objective of this study was to know if communities are willing to pay for improving quality and reliability of their drinking water systems and irrigation water. We grouped the responses in three categories when analysing the willingness to pay for water quality and quantity. The lower categories consisted all WTP figures of less than Tsh10,000 per year; the second categories comprised individuals willing to pay between Tsh10,000=50,000 per year; and the upper categories comprised those willing to pay more than Tsh50,000 per year. Table 2 presents the results.

Table 2: Willingness to pay for domestic water use results

Variable (A)	Sample size (B)	Percentage of Total	Mean (C)	Sum (B times C)
Lower categories	149	(20%)	3876.51	577,600
Middle categories	422	(58%)	20581.52	8,685,400
Upper categories	159	(22%)	64807.55	10,304,400
Total	**730**	**100%**		**19,567,402**

Table 2 shows that a majority of the respondents (more than 50%) are in the middle category that is willing to pay Tsh10,000=50,000, which may generate about Tsh9 million per year. The upper categories, though, comprise a little small percentage of the sample, and can generate slightly above the middle categories. The sample presented in Table 2, comprises only those who were not willing to pay twice as much of the then current level for irrigation and domestic use.

It can be the case that average WTP presented above can be seen to be higher to some sections of the population in that sub-sample. Tables 3 and 4 present the resulting contribution of each category when we take the lower and upper bound of the respective category.

Table 3: Lower bound distribution of domestic water use WTP per year

Sample population	Percentage to total population	Household Water use per year	WTP/lt of water (Tsh/lt	WTP (lower Bound)	Sample Total WTP	Corresp. Basin Population (Households)	Population Total WTP (Tsh)
149	20	73,000	0.014	1,000	149,000	122,202	122,202,000
422	58	73,000	0.14	10,000	4,220,000	354,386	3,543,860,000
159	22	73,000	0.69	50,000	7,950,000	134,422	6,721,100,000
730	**100**	**73,000**	**0.84**	**61000**	**12,319,000**	**611,010**	**10,387,162,000**

Table 4: Upper bound distribution of domestic water use WTP per year

Sample population	Percentage to total population	Household Water use per year	WTP/lt of water (Tsh/lt	WTP (lower Bound)	Sample Total WTP	Corresp.Basin Population (Households)	Population Total WTP (Tsh)
149	20	73,000	0.14	10,001	1,490,149	122,202	1,222,142,202
422	58	73,000	0.68	50,001	21,100,422	354,386	17,719,654,000
159	22	73,000	1.03	75,000	11,925,000	134,422	10,081,650,000
730	100	73,000	1.85	135,002	34,515,571	611,010	29,023,446,202

Taking into consideration the whole population size of the Rufiji Basin with respect to the corresponding percentage of the sample population, we can be able to establish the amount of revenue that can be collected for a period of 1 year. The results suggests that, on average, households in the low bound category were willing to pay approximately Tsh17,000 per annum for water services, which is about Tsh1417 per month. This is approximately half of what they were then paying. On the other hand, the upper bound category were willing to pay about Tsh47,500 per annum, which is approximately Tsh3,958 per month. This is slightly higher by 32% than what they were currently paying for domestic water use.

Determinants for WTP for Water Environmental Services

Results from the regression estimates reveal interesting outcomes of the determinants of WTP in the Rufiji basin. Table 5 presents regression results of the open-ended questions where the response are censored at zero, with WTP equals 1, when the household is willing to pay twice the current rate; and zero if otherwise. The objective here is to analyse the determinant of the willingness to pay for both domestic and irrigation water use. Various factors can explain the decision of a household willing to pay for domestic or irrigation water. However, in this case we try to test some of those potential determinants.

Table 5: Marginal effect of the probit estimates of WTP responses

WTP for Domestic water				WTP for Irrigation Water		
Variable	*Coefficients*	*Std. Err.*	*Z*	*Coefficients*	*Std. Err.*	*Z*
Sex	-0.008	0.050	-0.160	0.230	0.156	1.480
Log of Age	-0.176**	0.068	-2.170	-0.217	0.269	-0.810
Religion	0.057	0.053	1.090	-0.226	0.194	-1.160
Place of Birth	0.063	0.054	1.150	0.014	0.148	0.100
Iringa region	0.036	0.088	0.420	-0.059	0.192	-0.310
Mbeya region	-0.170	0.116	-1.460	-0.431**	0.179	-2.420
Coast region	0.236	0.116	2.030			
Capacity to manage	0.090**	0.044	2.060	0.365**	0.147	2.480
Conservation activities	-0.081*	0.053	-1.620	0.420***	0.135	3.110
Pay for water use	-0.055	0.055	-1.000	-0.073	0.202	-0.360
Primary complete				0.357**	0.174	2.050
Secondary complete				0.362***	0.105	3.470
Post graduate				0.585***	0.227	2.580
Effective	-0.007	0.051	-0.150	0.306**	0.123	2.480
Log of household income	0.028**	0.013	2.180	-0.021	0.043	-0.480
Fertilize user				1.04	0.60	1.73
Distance to water source				0.259*	0.145	1.780
Years lived in the village	-0.032	0.021	-1.580	0.048**	0.019	2.490
Log fuel cost	0.015**	0.006	2.390	-0.117	0.196	-0.600
Wood source	0.092**	0.047	1.950	0.280**	0.131	2.130
Benefit from the river	0.144*	0.084	1.730	-0.292	0.218	-1.340
Link	0.131**	0.055	2.360	0.373***	0.119	3.130

Note: *, **, *** are significant at 10%, 5% and 1% significant levels

In this case, zero response does not imply that the household is not willing to pay, but should be interpreted that the particular household is not willing to pay twice the current rate. The dependent variable is the WTP responses which is censored at 0, 1. This type of data is always meaningful to interpret in terms of the marginal effect, as the variable changes from zero to one (Long, 1997). For example, if the variable *log of Age* is significant and negative, this will suggests that a percentage increase in the age of the households will reduce willingness to pay by approximately 0.18. Similarly, variable *Pwani region* is defined as 1 if the household is from the Coast and 0. Otherwise this will mean that if the household is coming from Pwani region it is likely that it will pay for domestic water use; and the likelihood is 0.24. This result is not surprising since our data show that more than 90% of households in Rufiji district in the sample were paying for domestic water use, but none was paying for irrigation water.

Similarly, the results further show that if the individual is coming from Mbeya, it is likely that s/he will not pay for irrigation water; the variable *Mbeya region* is significant and negative for irrigation water use.

It is interesting to note from the results that *religion* variable is insignificant in both cases, suggesting that the WTP to pay for water environmental service does not depend on one's religious beliefs. One would expect people with strong religious beliefs to have less WTP for environmental services which are considered as a gift from God, and therefore no one should pay for it. This is interesting and contrary to the sentiments expressed by some of the respondents that water was a God given gift to be used by His creations.

Respondent's maximum willingness to pay was related positively to the income in domestic water use. As expected, people with higher incomes were willing to pay more to improve the quality of their drinking water. Because more than 95% of household income in the sample comes from agricultural activities, it implies that a 1% increase in agricultural income—resulting probably from irrigation and other factors—is likely to increase the household's willingness to pay by 0.02 point for domestic water use. This supports the view that often emerged during interviews and focus group discussion that people can increase the payment for water use if assured of constant supply and good quality water; and if they can increase their harvests. As should be expected, the age variable is significant and negative. This is an indication that older people are less willing to participate in conservation measure; or else can be interpreted also to imply that their ability to farm is getting less and less as they get older, and hence found it unprofitable to pay for irrigation water.

The *capacity* variable, which measures individual perceptions regarding forestry department, is positive and significant in both domestic and irrigation water use. This suggests that if a household perceives that the forestry and beekeeping division was capable of protecting catchments areas, then there is likelihood to pay for conservation cost. Similarly, when there were conservation activities going on within the respondent's village, it was likely that the household was willing to participate in the programme. The variable is positive and significant in irrigation water. However, this same individual is less likely to pay for domestic water use!

Education appears to play a crucial role in influencing one's decision to pay for environmental services. Variables related to education categories of the respondents are all positive and significant; also their magnitude suggests one's willingness to pay more if s/he acquires more education.

Furthermore, the results in Table 5 show that the longer the distance one has to travel to collect fuel-wood, and the benefit they get from the use of the river, the more likely that the household will be willing to participate in the programme. The variables *fuel cost, wood sources and benefits from the river* are all positive and significant in both models. Also if the household perceives that there is a link between water related-problem (e.g., shortages) and the environmental degradation, then it will be willing to participant in the program. The variable *link* is positive and significant.

The use of fertilizer indicates that it increases the willingness of households to pay for water services. This implies that the use of fertilizer means more likelihood of getting bumper harvest; everything held constant and hence higher income.

Table 6 presents regression results of the WTP. In this case, the dependent variable is continuous. These are responses of open-ended questions for households that were not either currently paying for either irrigation or domestic water use; or those which were currently paying but not willing to pay twice as much the rate. What we are interested to see here are factors that can potentially explain why a particular household is willing to pay but not willing to pay twice the current rate, even if the quality and quantity is to be improved.

Table 6: Regression Parameter Estimates of determinant of WTP>0

Log of WTP	Coefficient	Std. Err.	T
Constant	10.34***	0.39	26.26
Sex	0.16*	0.10	1.72
Farmer	0.31**	0.14	2.28
Place of birth	-0.13	0.09	-1.54
Iringa	0.17	0.19	0.91
Mbeya Region	-0.18*	0.11	-1.66
Coast Region	-0.61*	0.27	-2.28
Religion	-0.14	0.13	-1.05
Log of acres owned	0.21***	0.07	3.14
Log agric. Income	0.113**	0.024	2.480
Paying for water	-0.06	0.10	-0.61
Log of maize harvested	-0.04	0.05	-0.76
Conservation	0.14*	0.08	1.68
Effectiveness	0.20*	0.11	1.79
Education	0.21**	0.09	2.41
Benefit from the river	0.29*	0.17	1.69
Link	0.08	0.09	0.92
R-squared			0.48
Numb of observations			392

In this sub-sample analysis, the income variable is still positive and significant; indicating that as the income increases, the household is willing to pay for water services. Similarly, the size of the farm which is measured by the number of acres owned by a household has a positive effect on the willingness to pay. It suggests that if the farm size is to increase by 1%, then the household will increase willingness to pay by 0.21%. This is consistent with the welfare theory since land size can be considered as a sign of wealth, and hence likely to influence one's decision to pay. If people perceive that there are conservation activities taking place, then the willingness to pay for water service is likely to increase.

The education level of the household appears to influence the decision to pay for environmental service. This is good as it indicates that with more education, a household can easily be made to understand the linkages of problems related to environmental degradation. A percentage increase in education will lead into 0.21% increase in willingness to pay.

Conclusion and policy implications

This study revealed that slow implementation of government policies towards providing clean, safe, and potable water for all has led communities around Rufiji basin to seek outside assistance to build their own drinking water systems. Responding to local communities concern with water quantity and quality, this study sought to estimate if households would be willing to pay for improved supply of water for domestic and irrigation purposes due to improved environmental conservation. Rural households and irrigators were asked to state their willingness to pay (WTP) for improvements in the quantity, quality, and reliability of water supplies in the face of dwindling water flows. The identified samples of water users for large and small-scale irrigators were surveyed and the contingent valuation methods (CVM) were used.

In analyzing the willingness to pay for water services for domestic use, the lower bound WTP indicates it can contribute about Tsh10.3 billion per year, and the upper bound Tsh29 billion per year. Taking the population of the basin, which was 611,010 in 2002, it implies that each household would pay about Tsh64,500 per year, which translates into Tsh5375 per month. This is approximately twice the amount they are currently paying for domestic water use. The WTP for water for irrigation purposes indicates a lower bound and upper bound of about Tsh9.6 billion and Tsh110 billion per year respectively. These figures are quite substantial, and if used properly can help in conserving water catchments, thus improving water quality and quantity. The big challenge here—and which also the main concern to many of the respondents—were the management of the fund that will be raised. Many respondents were sceptic that things will not work out if the government will take the full control of the fund. Many felt that the management of the fund and how the fund should be utilized should be in the hand of an independent board that will involve all the stakeholders.

Furthermore econometrics analyses revealed that a majority of the households in low altitude and high altitude were willing to pay sizeable amount. Factors that were found to have significant influence in the willingness to pay were income, education, perception of households on the capacity of forestry department to manage catchments, and the age of the respondents. The amount that could be raised is a sizable, relative to existing tariffs for potable and irrigation water. This study suggests that the costs of watershed management could be covered, at least in part, by capturing its associated local benefits. This has significant implications for the decentralization of water resource development.

Despite the good results from both the econometric analysis and the willingness to pay estimation, the current institutional setting does not provide the avenue for this kind of decentralization, fee collection, and allocation; as well as the sharing mechanism of the environmental benefits and costs. In order to make payment for environmental services (PES) a reality on the ground, several measures need to be undertaken by the government. A study by Kulindwa (2004) provides a number of recommendations aimed at making PES implementable. These include revising and enacting new regulations to make PES legally operational, and adjustment of the current basin water boards to accommodate the new demands on management of hydrological services of catchment forests. Others include creating awareness on PES to all stakeholders with respect to what it is, and its costs and benefits. Also the government should work towards making the payments for water environmental services work for their intended goal through a management structure which represents all the stakeholders in the collection and allocation of funds for water use and watershed conservation.

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