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Women, Wealth and Waterborne Disease: Smallholders' Willingness to Pay for a Multiple-Use Water Scheme in Ethiopia

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ABSTRACT *This article identifies factors which contribute to households' willingness to pay for improving and protecting a multiple-use water scheme in Ethiopia. It does so through descriptive statistics, a probit model and contingent valuation methods complemented with qualitative data. Estimates suggest farmers' willingness to pay is based on gender, the prevalence of waterborne disease, the time to collect water, contact with extension services, access to credit, level of income and location. Respondents would pay 3.43 per cent of average income to participate. Consideration of how gendered norms influence women's access to extension, credit and local markets could extend the benefits of such schemes.*

1. Introduction

Intergovernmental Panel on Climate Change (IPCC) reports in 2007 and 2012 indicate most countries in sub-Saharan Africa will experience higher temperatures, more uncertainty regarding rainfall and a greater frequency of extreme weather events through the twenty-first century (Intergovernmental Panel on Climate Change [IPCC], 2007; Intergovernmental Panel on Climate Change [IPCC], 2012). Ethiopia itself has a very wide variety of climatic conditions with altitudes up to 4500 m, temperatures averaging between 15–25 degrees Celsius and rainfall ranging from 300 mm to 2000 mm. Recent decades have seen a gradual increase in temperatures and a slight increase in rainfall variability (Conway & Schipper, 2011). Moreover, Conway and Schipper (2011) concur with multi-model projections that average temperatures will increase by up to 1.2°C in the 2020s, 2.2°C in the 2050s and 3.6°C in the 2080s. The direction and extent of precipitation change is less clear. IPCC projections suggest a slight increase in east Africa overall by the end of the twenty-first century compared to 100 years earlier. National projections of rainfall in Ethiopia are mixed. Strzepek and Mccluskey (2006) report both increasing and decreasing scenarios depending on the model used. What is clear is that the spatial distribution of rainfall is changing. Famine Early Warning Systems Network (FEWS NET) (2012) report a 15–20 per cent decrease across southern, south-western and south-eastern areas, particularly the Rift Valley and Eastern Highlands (which display a marked decline in rainfall). On the other hand, the Western Highland region is likely to receive adequate if not greater amounts of rainfall from climate change. We can see that the projected changes in precipitation are likely to affect the supply of water in many arid and semi-arid areas, especially in lowland areas of Ethiopia. This is

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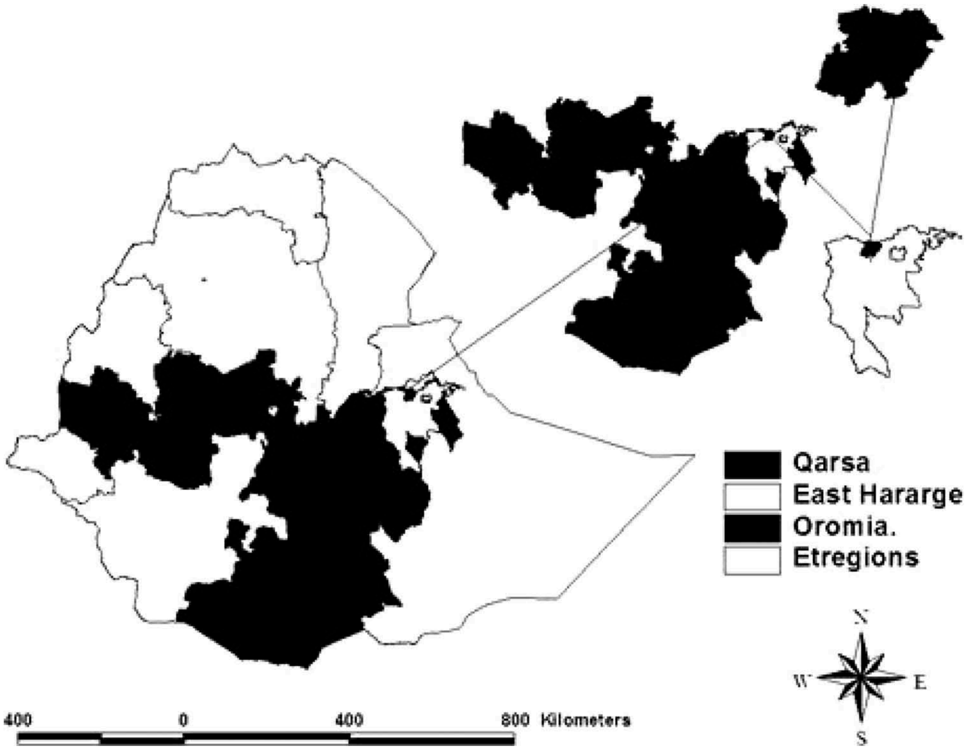

Figure 1. Location of study site.
Source: Authors.

reflected in climate adaptation policy frameworks such as the Ethiopian National Adaptation Programme of Action (NAPA) which ranked the development of small-scale irrigation and water harvesting schemes as the third most important adaptation priority for the country (Government of Ethiopia [GoE], 2007).

The management of scarce water resources in such dry areas has shifted slowly from a supply-driven perspective to a more demand-driven approach in recent decades, particularly towards multiple-use schemes. Proponents of combining productive and domestic uses claim such schemes can maximise the productive potential of supplies (see Faal, Nicol, & Tucker, 2009), leading to higher incomes, improved health and reduced workloads for women and children (Moriarty, Butterworth, van Koppen, & Soussan, 2004). Moreover, proponents assert multiple-use systems are more likely to be sustainable as users benefit more and are more willing and able to pay for schemes.[1] However, maintaining, protecting and improving multiple-use schemes requires collective action by smallholders who often do not have a viable institution to facilitate the process. The development of such institutions depends on the values different users place on water resources, including the degree to which users are willing to pay for the provision of improved and protected water resources. This article aims to contribute to debates on climate adaptation by offering data from Kersa District, Eastern Hararghe Zone, Oromia Region, located in the east of the country towards Somalia. It estimates smallholders' willingness to pay for improving a water scheme constructed by International Fund for Agricultural Development (IFAD) as the only multiple-use scheme in the district. The scheme was constructed to provide domestic water supply services (drinking, sanitation, laundry, cooking) as well as productive uses (mainly irrigation and a water source for livestock). By improvement, the article refers to the reform of the water user association including a shift from labour contributions to cash contributions to ensure the longevity of the scheme. The article highlights the factors that increase the likelihood of a household being willing to make a financial contribution to the scheme.

The article is structured in four further parts. First, a literature review offers an overview of multiple-use water resource systems, methods for valuing environmental resources and introduces the analytical framework used in this study. The next two sections cover the research methodology and methods, and results and discussion, respectively. The final section concludes.

2. Literature review

Multiple-use water services are defined as a 'participatory, integrated and poverty-focused approach which takes people's multiple water needs as a starting point for providing integrated services' (International Water Management Institute [IWMI], 2006, p. 6). If appropriately planned and managed, it is claimed multiple-use water schemes can reduce poverty, reduce health hazards and limit the vulnerability of rural households (Moriarty et al., 2004; Van Koppen et al., 2009). It is also suggested multiple-use schemes can improve gender equity and cost recovery leading to longer-term water supply (Fontein, 2007).

International Water Management Institute (IWMI) (2006) outlines three stages in multiple-use schemes: first, the assessment of both productive and domestic water requirements through discussions with end users; second, the examination of water sources such as wastewater, rainwater and piped systems; and third, matching water supplies to communities based on requirements. IWMI (2006) argues by separating productive and domestic demand, marginalising community participation and ignoring the full range of water sources available, conventional water supply schemes fail to be efficient, equitable or durable (see also IWMI, 2006; Jeths, 2006). In case studies from Bolivia, Colombia, Ethiopia, India, Nepal, South Africa, Thailand and Zimbabwe, Smits, Renwick, Renault, Butterworth, and van Koppen (2008) found that respondents almost universally use water for both domestic and productive activities. In addition, Smits et al. (2008) found that different types and combinations of technologies can improve levels of access, especially through multiple-use schemes.

Ethiopia has recognised the importance of the multiple-use water services approach. Whilst most water-use systems in Ethiopia are single use, interest in constructing and using multiple-use schemes in Ethiopia is increasing (Adank et al., 2006). For example, Catholic Relief Service (CRS), one of the development partners of the International Water Management Institute in Addis Ababa, is a strong promoter and implementer of the multiple-use water services approach. Moreover, the Ethiopian water strategy now assigns priority to irrigation projects which are multi-purpose. Former domestic water-supply services have been upgraded to enable small-scale irrigation and vice versa. A small number of studies have started to evaluate these multiple-use schemes. For example, Adank et al. (2008) compare the cost and benefits of both single-use and multiple-use schemes. They conducted cost-benefit analysis for three case studies: Ido Jalala, Ifa Daba and Biftu Diramu from East Hararghe Zone, Oromia Regional State, Eastern Ethiopia. The results suggest even in the worst-case scenario, the incremental benefits of multiple-use schemes easily outweigh the incremental costs at the system and household level. A key parameter in all these estimations is households' propensity to pay to receive improved water supplies. We now present some of the valuation methods commonly used in the literature, highlight some of the limitations of the techniques and how these can be mitigated, and discuss the emergent literature on multiple-use water services in Ethiopia to which we aim to contribute.

2.1. Methods for valuing environmental resources

In a market economy goods and services are allocated by the price mechanism. Market prices reflect people's willingness to pay for marketable goods and services. However, this is difficult for environmental resources as they are not traded in markets. It is thus hard to place an accurate value on them (Perman, Gilvray, & Common, 2003). To overcome this problem, 'observed' and 'hypothetical' methods of valuation have been developed (Freeman, 1993). The former involves inferring values for public goods through related markets, thus relying on *revealed preferences*. This can be done either based on observed behaviour or based on some marketed good. The most commonly used methods under revealed preference techniques are ‘travel cost’ and ‘hedonic’ pricing. The former seeks to place a value on non-market environmental goods using consumption behaviours in a related market. Specifically, the costs of consuming the services of the environmental asset are used as a proxy for price. The latter compares the market value of two products that differ only with respect to a specific environmental attribute. Researchers assess the implicit price of that amenity (or its cost when undesirable) by observing the behaviour of buyers and sellers.

The second category, which we focus on in this article, relies on constructed or hypothetical markets. These approaches can be termed *stated preference* methods, with choice experiments and contingent valuation methods (CVM) currently the most commonly used approaches in empirical studies. With choice experiments, the value of any good is assumed to depend on the good’s attributes. Individuals are presented with a series of choices, and for each choice set they must state what option they prefer. Respondents are asked to make repeated choices between different consumption bundles with different attributes. Typically, one of these attributes is price. This procedure enables researchers to obtain information on: the attributes that influence choice; an implied ranking of these attributes; and the marginal willingness to pay for an increase or decrease in the significant attributes (Hanley, Wright, & Adamowicz, 1998). Logit and probit models are used to estimate probabilistic choice models from which willingness to pay for marginal changes in attributes can be derived.

Turning to contingent valuation, Randall, Hoehn, and Brookshire (1983, p. 637) define this approach as:

> asking individuals, in survey or experimental settings, to reveal their personal valuations of increments (or decrements) in unpriced goods by using contingent markets.

Thus, values obtained for the good or service are contingent on the nature of the constructed (hypothetical or simulated) market as well as the good or service described. Knife & Berhanu (2007) states that CVM help researchers capture the total value of a good – both use and non-use values – and its flexibility facilitates valuation of a wide range of non-marketed goods. This makes the method the most preferred valuation method.

Contingent valuation questions can be of two basic forms: open or closed. In an open question, the respondent states the maximum amount that s/he is willing to pay for the good being valued. With a closed question, also referred to as ‘dichotomous choice’ or ‘referendum’ question, the respondent chooses from a series of amounts (Gunatilake, Yang, Pattanayak, & Choe, 2007; Gunatilake, Yang, Pattanayak, & Van Den Berg, 2006; FAO, 2007). The typical CVM scenario is the single measurement of the monetary value of a single environmental project with the discounted stream of benefits from the project calculated.[2] If properly managed, well-designed and soundly executed CVM studies can provide high-quality and policy-relevant information. For example, more than 80 per cent of the studies using CVM for clean water have so far predicted prices correctly (World Bank, 2004). However, the application of the method requires care to get a reliable result. CVM does suffer from a number of biases. We now discuss these and some ways to overcome such shortcomings.

Much of the early CVM literature focused on testing for and identifying biases (Carson, Flores, & Meade, 2000). CVM assumes respondents understand the good in question and will reveal their preference in the contingent market just as they would in reality. However, most respondents are unfamiliar with placing monetary values on environmental goods/services and therefore may have an inadequate basis for stating their true preference (termed hypothetical bias – see Gunatilake et al., 2007). Four of the further major biases are now summarised:

Free riding and strategic behaviour bias is the most commonly reported problem in the CVM literature. Based on utility maximising assumptions, individuals can understate their Willingness to Pay (WTP) for a public good on the assumption others will pay for its provision. If an individual feels others’ payments will be sufficient to ensure the provision of a good, then s/he has an incentive to free ride by lowering her/his WTP bid below its true valuation. On the other hand, if an individual is particularly keen on a good and calculates the decision regarding provision depends upon the mean valuation of a sample then s/he may behave strategically and overstate his true WTP in an effort to raise that mean and thereby ensure provision (termed strategic bias).

Starting point bias arises when the initial value suggested influences respondent's willingness to pay. Kartman, Stålhammar, and Johannesson (1997) state three possible sources for this bias. First, bias could arise from a poor understanding of the good. Second, a significant difference between respondents' willingness to pay and the starting value suggested can create bias. Finally, respondents may assume the true value of the good is around the given starting point.

The third further form of bias is *information bias* which occurs when the survey instrument is not well designed, and respondents may interpret questions differently from how they are intended by the researcher. This can be reduced by designing the survey carefully, training interviewers and supervising the survey well (Gunatilake et al., 2007).

Finally, *instrument bias* arises if the respondent is hostile to the means by which payment is to be collected (for example, a local tax or entrance fee). Controversial payment vehicles should be avoided in favour of those most likely to be employed in real life (Georgiou, Langford, Bateman, & Turner, 1998). Respondents can be asked to choose the payment vehicle of interest during the pilot survey to resolve this problem. A summary of biases in CVM water supply and sanitation studies are summarised in Table 1.

CVM has been applied to the provision of water supply services in rural and urban Ethiopia numerous times. Here we outline the findings from five studies. Dunfa (1998) used CVM to assess the WTP for improved rural water supply in Ada'a-Liben District, West Showa Zone, Oromia Regional State. An ordered probit model was used to analyse the variation of WTP for improved rural water supply. Findings suggest income, time to collect water, status of water quality, education and credit availability have a positive influence on the WTP. The study also indicated that 54 per cent of surveyed households were willing to pay.

Genanew (1999) employed CVM to analyse the households' willingness to pay for improved water service in Harar Town, Harar Regional State. In this study ordered probit and ordinary least square

Table 1. Types of biases and remedial measures to minimise bias

Bias	CVM risks in water supply and sanitation studies	Measures for minimising bias
Hypothetical: Respondents provide hypothetical answer to value a commodity offered in the future	Medium	Formative research (focus groups, key informant) discussion to understand the context and the commodity. Proper CV scenario design, appropriate and credible payment vehicle, debriefing questions, CV scenario with minimum uncertainty of the provision of the commodity
Free riding and strategic behaviour: Respondents intentionally deceiving the enumerator	Medium	Proper elicitation question, proper debriefing questions, removal of the questionnaire if there is clear evidence of strategic answers.
Starting point: Respondents anchor to the initial values given to them.	High	Proper elicitation question, proper bids with adequate range. Closed-ended questions may have very small starting point bias.
Information bias: Researchers influence the choice. Respondents attempt to please.	High	Enumerator training on neutrality, questionnaire pretesting, focus group discussions, and supervision during survey implementation.
Instrument bias: If the respondent is hostile to the means by which payment is to be collected	Medium	Controversial payment vehicles should be avoided. Respondents can be asked to choose the payment vehicle of interest during the pilot survey.

Source: Compiled by authors from Carson et al. (2000); Gunatilake et al. (2007).

(OLS) models were used to estimate the relationship between the household responses with the set of hypothetical determinants. For the latter, Genanew (1999) used median willingness to pay in the bidding game as the dependent variable. The findings suggest that coefficients of income, education, gender, location, starting bid and quality of existing water supply significantly determine households' WTP. His findings also show that all surveyed households preferred the provision of an improved water service. The surveyed households show their WTP was about 15 times more than the existing tariff for an improved service.

Alebel (2002) also analysed the willingness to pay for improved water service in urban areas of Ethiopia but this time by taking Nazreth as a case study. The results show 42 per cent of respondents do not have a private connection to existing water services and 96 per cent expressed a willingness to pay for improved water services. On average, respondents are willing to pay 0.47 USD per m3 (in 2010 constant dollars).

Finally, Bogale and Urgessa (2012) conducted a CVM study in eastern Ethiopia using double bounded dichotomous choice elicitation method. The results from a probit model were that household income, education, gender, time spent to fetch water, water treatment practices, the quality of water and expenditure on water had positive significant effects on WTP. Interestingly, age of the respondent had a negative and significant effect. The estimated WTP was 27.3 cents per 20 litre bucket. As households' average use was 66 litres per day, this equated to 9.06 USD per year (in 2010 constant dollars) or 1.99 per cent of average income.

We add to this body of literature on single-use water schemes by studying the factors that contribute to WTP for a *multiple-use* water scheme in Kersa District. We now present the description of the study area, the sampling techniques and methods of data collection and analysis.

3. Description of study area

Our study was conducted in one of the 21 districts of the Eastern Hararghe zone. It is located 475 km east of Addis Ababa (see Figure 1).[3]

Kersa district is characterised by a mountain topography ranging between 1400–3200 metres above sea level and consists of highland (7%), mid land (91%) and low land (2%). Average rainfall and temperature varies between 600–1900 mm and 18°C – 24°C per year, respectively (CSA, 2010). The district covers an area of 54,494 hectares (544.94 km^2) divided into three urban kebeles and 35 peasant associations. Around 70 per cent of land is cultivated, 2.8 per cent is grazing land and less than 0.2 per cent is natural forest and water courses (Kersa District Office of Agriculture and Rural Development [KDOoARD], 2010). Total population in 2007 was estimated at 172,626 with a rural population of 160,772 (Central Statistical Agency [CSA], 2010). The district comprises 17,945 households with 21 per cent headed by women. The average household size is five persons and population density is 317 per km^2, making it the most densely-populated district in the zone. In terms of ethnic group, Oromo constitute 95 per cent of the population and the remaining 5 per cent is made up from Amhara and other ethnic groups. Muslims, Orthodox Christians, and Protestants constitute 85 per cent, 10 per cent and 5 per cent, respectively (CSA, 2010).

Rural communities mainly depend on a mixed farming system, where production of crops such as cereals, vegetables, khat and coffee is supplemented by animal husbandry. Livestock is an integral part of nearly all farming systems in the study area. Almost 37 per cent of the population are considered food insecure. Among the notable problems limiting food production in the area are inadequate moisture, poor irrigation facilities and poor utilisation of inputs.

Domestic water supplies mainly come from groundwater hand pumps. As the study conducted by the Ministry of Water Resources and Energy indicates, this water source is diminishing over time. There is one major river in the district that is used for irrigation, two lakes (one seasonal and one perennial) and 35 springs. Our study focuses on the improvement of the Burka Multiple Water Use Scheme, constructed by the support of the International Fund for Agricultural Development (IFAD) in the district. The construction was completed in 1995 to irrigate 175 ha for 581 households

(KDOoARD, 2010). At the time of the survey, current users were paying for the maintenance and improvement of the scheme not in cash but in kind: they contributed their labour via a water user association. Monetary costs were still being met by the donor. To ensure the long-term viability of the scheme, members of the water user association were asked about their willingness to pay, the results for which we report here.

The survey employed a three-stage sampling technique to select farmers. In the first stage, Kersa district was purposively selected due to the availability of the above-mentioned multiple-use water scheme. In the second stage, two peasant associations (PAs) were purposively selected on the basis of the availability of the multiple-use scheme nearby. The two PAs selected were Handhura-Kosum and Mada-Oda. In the final stage, farmers in the two sampled PAs were selected randomly based on probability-proportion-to-size sampling to maintain an equal distribution of sample respondents in each peasant association (with 76 and 64 households sampled, respectively). Respondents were the household head. The survey was conducted in April to May 2010. The agricultural and income figures refer to the 2009/2010 production year.

The primary research had three phases: first, PRA techniques to understand the context and to examine a good range for the starting bid; second, a pre-test of the survey questionnaire; third, the formal survey including CVM questions. The study generated data on 140 households. Six enumerators fluent in the local language were trained on the questionnaire, data collection methods and how to approach farmers on CV questions. In order to generate qualitative data, we carried out personal observations and two focus group discussions with selected groups.

The design of the questionnaire was divided into three sections. The first section contained questions about water availability, water utilisation and extreme weather events. It also asked about water consumption expenditure (sources, means, and costs) and whether their consumption decisions are affected by the water service delivery mode (type) and availability of multiple-use water services.

The second section presented information on water utilisation practice in the region with special focus on multiple-use water systems. The section then presented a detailed description of multiple-use water systems and asked if respondents would adopt such a scheme. Respondents were then asked if they would be willing to pay a specified amount to make sure they have access to multiple-use water services. A single-bounded dichotomous choice elicitation method (Bishop & Heberlein, 1979) was used. Five different bid values (identified and classified through PRA techniques and pretesting) were used and randomly allocated to people within the sample. Respondents were then asked whether the price of the service indicated by the WTP amount would affect water use. Respondents were also asked their maximum WTP to address all of their multiple-use scheme concerns using an open-ended format. Following this section, there was a series of debriefing questions: respondents were asked to explain their responses to the WTP questions; to explore the rationality of respondents and to test specific biases. The third and final section of the questionnaire contained detailed demographic and socio-economic variables across five livelihood dimensions to which we now turn.

Following Ellis (2000), we consider assets (human, natural, social, financial, physical) and institutions/mechanisms as factors which contribute to WTP. Assets are the basic building blocks upon which households are able to undertake production, engage in labour markets and participate in reciprocal exchanges with other households (Ellis, 2000). These assets are owned, controlled, claimed or accessed by household members. Both endogenous mechanisms (social relations, institutions and organisations) and exogenous trends and shocks are critical mediating factors for transforming assets into livelihood strategies and outcomes. In a similar vein, Cleaver and Franks (2005) and Smits et al. (2008) not only stress the importance of assets (or broader resources) but also the ever-changing mediating processes and mechanisms influencing actors. We assess the importance of assets and mechanisms that mediate these assets through combining data from quantitative and qualitative research methods, respectively.

3.1. Data analysis

We employ descriptive statistics and econometric analysis to estimate farmers' willingness to pay. Descriptive statistics are used to explain the characteristics of the sample households in terms of the five livelihood capitals (Ellis, 2000). These include mean, percentage and frequency figures for willing and non-willing farmers to pay for protecting and improving multiple-use water scheme. The statistical significance of the variables was tested using chi-square (χ^2) and t-tests dependent on the nature of the data (dummy, discrete or continuous). Once data quality was assured through the examination of descriptive statistics, we proceeded to perform three estimation procedures. Firstly, we undertake validity tests.[4] Secondly, we analyse the factors contributing to WTP using a probit model. Finally, we estimate the mean WTP using this model.[5] A summary of variables used in the probit model, their measurement and the expected direction of change are presented in Table 2. We cluster the variables under the characteristics of the multiple-use scheme and the five asset capitals categorised by Ellis (2000). We also include an interaction term. When discussing quantitative results, we reflect on the role of local institutions and mechanisms in contributing to households' willingness to pay.

Table 2. Variables, their measurement and key hypotheses

Variable	Name	Type of variable	Hypothesis	Measurement
MUS				
Access to MUS	ACCEMUS	Dummy	+	1 if user, 0 otherwise
Maintenance and operation	MANOPER	Dummy	+	1 if household faces, 0 otherwise
Initial bid value	BIDVAL	Discrete	-	Birr per year
Number of uses from MUS	NOUMUS	Discrete	+	Number of uses the household is allowed to have from MUS
Human capital				
Age of the household head	AGE	Discrete	±	Years
Gender of the household head	SEX	Dummy	+/-	1 if male, 0 otherwise
Educational level of household head	EDULEVEL	Discrete	+	Maximum education level
Total family size	TOTFS	Discrete	+/-	Number of family members in the household
Dependency ratio	DEPRAT	Continuous	+/-	Ratio
Water-borne disease	WABODIS	Dummy	+	1 waterborne disease, 0 otherwise
Social capital				
Extension contacts	EXTCON	Discrete	+	Number per year
Natural capital				
Shortage of water	SHORTWA	Dummy	+	1 if household faces, 0 otherwise
Availability of own water source	OWNWATSO	Dummy	-	1 owned own source, 0 otherwise
Time to fetch water	TIME	Continuous	+	In minutes
Size of livestock holding	TLU	Continuous	+	Numbers in TLU
Proportion of irrigated farm	PROPIRFAR	Continuous	+/-	Ratio
Financial capital				
Access to credit by the household	ACCREDT	Dummy	+	1 if has access, 0 otherwise
Total income	INCOME	Continuous	+	Birr per year
Physical capital				
Distance from district market	DISMARKT	Continuous	-	Minutes
Peasant association	PA_DUMM	Dummy	+/-	1 if Mado-Oda, 0 otherwise
Interactions	*INTERA*	*Indeterminate*	+/-	*Indeterminate*
Willingness to pay	WTPMUS	Dummy		1 if household is willing to pay, 0 otherwise

4. Results

We now present descriptive statistics of sampled households, the maximum likelihood estimates of the probit model results, and, finally, the mean estimate of willingness to pay for protecting and improving multiple-use water resources. We start with characteristics of the scheme. About 46 per cent of households in the sample were existing users of the scheme. Amongst users, 89 per cent were willing to pay for maintaining and improving the scheme. Only 61 per cent of those outside the current scheme were willing to pay. There is a strong statistically significant relationship (χ^2 = 14.18) between current use of the multiple-use scheme and WTP (at the 1% level). Farmers were asked whether they perceived or expected any problems associated with the construction and maintenance of the multiple-use scheme. Around 35 per cent of respondents reported current or expected problems with the scheme. Of these, around 79 per cent were willing to pay. However, there was no statistically significant difference between willing and non-willing households (χ^2 = 0.98). The average number of uses of the existing multiple-use scheme was 1.47 per day (1.76 for the willing farmers and 0.61 for non-willing farmers significant at the 1% level).

We now run through the variables clustered under the five livelihood capitals. We begin with human capital. Eighty nine percent of sample respondents were male-headed whereas 11 per cent were female-headed households (FHHs). This is lower than the mean proportion of female-headed households in the district. Out of the total sample, 74 per cent of households were willing to pay for improving and protecting multiple-use water resources. Out of 125 male-headed households, 74 per cent were willing to pay compared to 80 per cent of FHHs although this was not statistically significant. The mean age of the household head was 38 years. Maximum and minimum ages were 66 and 20 years, respectively. Average formal educational attainment of the household was 3.26 grades. Average family size was 5.84 people, with an average dependency ratio of 1.07 per household. None of these differences were statistically significant using t-tests. Importantly, 20.2 per cent of those willing to pay reported water-borne disease as a problem compared to only 9 per cent of non-willing farmers (significant at the 10% level). We now turn to social capital.

On average, households had some contact with development agents 30.8 times per year, indicating good access to extension services. Farmers who were willing to pay for the multiple-use scheme have a significantly higher mean number of contacts (33.45) than non-willing farmers (23.27) (significant at the 1% level). Turning to natural capital, around 44 per cent of respondents reported water shortages as a problem. Surprisingly, a smaller proportion of willing households did so (42%) compared to non-willing households (47%). About 90 per cent of respondents did not own a water source. Of the 104 sample respondents who were willing to pay for improving and protecting the multiple-use scheme, 95 per cent did not own a water source compared to 75 per cent of non-willing counterparts (shown by the high χ^2 of 12.11 significant at the 1% level).

Livestock owned per household averaged 3.16 Tropical Livestock Unit (TLU). Households not willing to pay have a statistically significantly higher mean TLU score of 4.39 than willing households 2.74 (at the 1% level). This was surprising and appears to be related to the fact that households with higher TLU scores often owned a water source (and thus were less willing to pay for improving and protecting the multiple-use scheme). For example, households owning a water source owned, on average, six TLU whereas for others the figure was only three TLU.

Land is the main and most important resource owned by smallholders. Average landholdings were 0.47 ha. This is close to the national average (0.5 ha) but far from Oromia regional average of 1.14 ha (Gebremedhin, Jaleta & Hoekstra 2009). The proportion of irrigated farmland per household on average was about 0.27 ha (with willing households having a slightly greater proportion than others, significant at the 10% level). Households willing to pay for improving and protecting the multiple-use scheme tended to walk longer distance per day to fetch water for drinking than non-willing counterparts, but this association was not statistically significant.

Turning to financial capital, the mean annual total income per household was US$977.69 (US $1077.02 for willing farmers and US$690.73 for non-willing farmers in constant 2010 dollars). This difference is significant at the 1 per cent level. The survey also captured data on credit. Microfinance operations in the study area were negligible and the majority of farmers (82%) had no access to credit. For those who had access to credit, the main source was government. Out of respondents who had access to credit, 96 per cent were willing to pay for the multiple-use scheme compared to only 70 per cent of those without access to credit (significant at the 1% level).

We now turn to the final livelihood asset: physical capital. The minimum and the maximum times required to reach the nearest market centre were 10 and 160 minutes respectively. On average, willing farmers walk 19 minutes while the figure was 47 minutes for non-willing farmers. We find the difference of 28 minutes statistically significant at the 1 per cent level. In terms of geographical location, 46 per cent of the sample respondents were located in Mada-Oda peasant associations. The remaining 54 per cent were residents in Handoro-Kosum. A significantly greater proportion of households in Mada-Oda were willing to pay, again significant at the 1 per cent level.

4.1. Results from probit model

Whilst the identification of bivariate relationships is helpful, it is not sufficient to get a rounded understanding of the determinants of households' WTP. This requires capturing the relative influence of each factor. We use a probit model to identify the relative influence of different variables on the probability of WTP. Maximum likelihood estimates for the probit regression model are presented in Table 3.

The probit model suggests eight variables significantly contribute to the WTP: gender and water-borne disease from human capital; time to fetch water from natural capital; access to credit and income from financial capital; extension services from social capital; and distance to the nearest market and location of peasant associations from physical capital. The signs of the coefficients turned out to be consistent with a priori expectations. We now discuss each of these significant variables.

The probit model suggests farmers' WTP is determined by two human capital variables: gender of household head and prevalence of waterborne disease. The results show male-headed households were 8 per cent less likely to pay for improving and protecting the multiple-use scheme compared to female-headed households, other variables held constant (significant at the 5% level). In rural areas in Ethiopia, women bear the burden of obtaining water. In view of this, a multiple-use scheme that improves water availability can also promote gender equity and social empowerment. Rural women can allocate the time saved as a result of improved water supplies into both productive and further social reproductive activities. This line of reasoning is supported by a variable categorised under natural capital: the time taken to fetch water. Ceteris paribus, a one-minute increase in the taken time to fetch water is associated with a 2.24 per cent increase in the probability of WTP for improving and protecting the multiple-use scheme (significant at the 10% level). That is, as the time needed to fetch water increases, respondents are willing to pay more for improved water services. The further significant human capital variable is health. Keeping the influence of other factors constant, households who consider waterborne disease a problem in their family have a 9 per cent higher probability of being willing to pay for the multiple-use scheme (significant at the 10% level). This also has a clear gender dimension – caring for sick relatives falls mainly on women. Reducing morbidity in the household can lead to fewer costs, possibly leading to greater productivity and higher incomes. These results suggest multiple-use schemes need to explicitly take gender into account when designing water rates and subsidy policies.

Turning to financial capital, we find total income has a very small positive but significant influence on the probability of being willing to pay for the multiple-use scheme. That is, a 10 per cent increase in income results in a 0.03 per cent increase in probability, ceteris paribus. Access to credit had much greater influence on the probability of WTP: controlling for other factors, households with credit are 12 per cent more likely to be willing to pay. PRA techniques noted households with credit were able to purchase inputs for production, increasing productivity and effective use of water resources. That is, credit strongly influenced the ability of households to use irrigation to increase productivity. But qualitative methods highlighted an important gender dimension at work here. It appears many women members were forced to rescind membership of the water users' association thus limiting access to

Table 3. Maximum likelihood estimates of the probit model

Variables	Coefficients	Std. error	Z	Marginal effects
MUS				
ACCEMUS	.9793287	.14331	0.98	.1405972
MANOPER	.2245327	.05487	0.56	.0308547
BIDVAL	−.0045204	.00043	−1.52	−.0006516
NOUMUS	−.0655589	.0413	−0.23	−.0094498
Human capital				
SQRT_AGE	−.157100	.04037	−0.56	−.0226459
SEX	−.9438241	.04152	−1.95**	−.0809403
EDULEVEL	−.0024031	.0104	−0.03	−.0003464
TOTFS	−.0651242	.01502	−0.63	−.0093872
DEPRAT	−.2172175	.03964	−0.79	−.0313103
WABODIS	.9393603	.04884	1.83*	.0892291
Natural capital				
SHORTWA	−.1176847	.05572	−0.31	−.0171481
OWNWATSO	−.7527545	.17966	−0.89	−.1601837
SQRT_TIME	.1559045	.01288	1.74*	.0224725
SQRT_TLU	.1460013	.03379	0.62	.021045
PROPIRFAR	−.101572	.14814	−0.10	−.0146409
Financial capital				
SQRT_INCOME	.0184148	.01288	2.86***	.0026544
ACCREDT	.1207543	.05215	2.32**	.1207543
Social capital				
EXTCON	.0467202	.00249	2.71***	.0067344
Physical capital				
DISMARKT	−.0254904	.00171	−2.15**	−.0036743
PA_DUMM	1.261908	.09952	1.82*	.1812873
___CONS	−.3021935			
Log likelihood = −37.609				
Number of obs = 139				
LR chi2(20) = 83.80				
Prob > chi2 = 0.000				
Pseudo R2 = 0.527				

Notes: ***, ** and * are statistically significant at 1 per cent, 5 per cent and 10 per cent levels, respectively.
Source: Survey results.

credit. In other words, it appears that whilst female-headed households are more willing to pay for a multiple-use scheme to reduce labour burdens, their ability to utilise improved water supplies to increase productivity is constrained by social norms and values which limit their access to liquidity. In this respect, multiple-use schemes need to ensure formal institutions do not reproduce existing patterns of inequity but try to ensure equal opportunities to all members (Mair & Marti, 2009).

Turning to social capital, the results of the probit model show contact with extension services, defined as a social capital variable, had a positive and statistically significant (1%) effect on the willingness of households to pay for improving and protecting multiple-use water. One extra contact increased the probability of WTP by 0.7 per cent. That is, both the agricultural and health benefits of multiple-use schemes are more visible to farmers who have been trained collectively. In this district, extension services involve group and individual-based training sessions on agricultural production (livestock rearing, crop production and natural resource management) and, in this context, on health-related issues. Such services facilitate interaction among households and help to build mutual relations in using common resources such as water effectively. Qualitative methods elucidated that three development agents from different fields of specialisation (crop husbandry, animal husbandry and natural resource management) were assigned by the Bureau of Agriculture and Rural Development to each peasant association. In addition, different NGOs operate in the area who also provide training on water use. It is interesting to note that some variables (such as access to and the number of uses of) the scheme which were significant in bivariate relationships turn insignificant after controlling for household characteristics and other social capital variables within the probit model.

Two physical capital variables also determine households' WTP. Distance from the district market centre affects farmers' WTP negatively (at the 5% significance level). Holding other variables constant, each extra minute of walking time decreased farmers' probability of being willing to pay by 0.4 per cent. Access to markets reduces transaction costs. Most farmers who have access to irrigation produce highly perishable crops that cannot be stored for long periods. According to qualitative techniques, most farmers aren't able to store produce adequately but rely on local spot markets. This implies efforts towards improving and protecting multiple-use water supplies should also address access to markets and storage constraints.

The other important physical capital variable determining farmers' WTP is location in one of the peasant associations (PAs). Table 3 shows households in Mada Oda were found to have a 18 per cent higher probability of WTP than households in Handhura-Kosum. Households located in Mada-Oda were found to have higher total incomes, a greater number of uses of the scheme and a greater proportion of land that was irrigated. On the other hand, they also had greater numbers of water sources and worse access to credit and extension services (presumably reducing their WTP).

Qualitative information also suggested that the two PAs are different in terms of climate variability and extreme weather events. According to PRA techniques, in the last five years weather and rainfall has varied greatly. Rainfall has been highly variable both within and between seasons, which is manifested in the quantity, intensity, and distribution of precipitation in the growing season. This greatly affects the income of farm households in the study area who depend on rain-fed cultivation. As Mada-Oda has been experiencing greater climatic variability, this could contribute to the greater probability of WTP. Overall, these location differences suggest the uniform application of water rates across peasant associations within a district may not be appropriate.

The results of the average WTP from the probit model was found to be US$33.57 per year (in 2010 constant dollars). The average WTP from the responses of open-ended CV survey question was US $16.13 per year. This figure is less than the mean values computed from the close-ended probit model estimates. As closed questions tend to have lower levels of strategic and very low levels of starting point bias than open-ended questions, the higher figure calculated will be given more weight and will be used to compare with the figures produced by Bogale and Urgessa (2012).

The results presented here dovetail with some of the findings from previous CVM studies conducted in rural Ethiopia for improved water service provision (see the descriptions above of Dunfa, 1998; Bogale & Urgessa, 2012). Dunfa's (1998) study, also in Oromia Regional State, found that income, time to collect water, and credit availability also had a positive and significant influence on the WTP. In addition, current water quality was a further contributing factor – similar to the role of waterborne disease in this study. They only factor not corroborated by our study is education.

Bogale and Urgessa (2012) conducted their CVM study in Haramaya District, one of the districts in East Hararghe, and again found a broadly similar set of significant variables: income, time spent to fetch water, water treatment practices, the quality of water and expenditure on water all had positive significant effects on WTP. Similarly to Dunfa (1998), Bogale and Urgessa (2012) found education to be significant. Similar to the present study, they also found gender to be significant. In addition to the variables from these two previous studies, the present study finds that access to extension services, and geographical variables (distance to the nearest market and peasant association) to be significant. Turning to estimates of WTP, Bogale and Urgessa (2012) found a WTP figure of US$19.13 per year (in constant 2010 dollars) which equalled 1.99 per cent of average income. Based on responses to closed questions, this study found a WTP figure of US$33.57 per year (in constant 2010 dollars), which equates to 3.12 per cent of the average incomes of those respondents who were willing to pay or 3.43 per cent of the average income of all respondents. Importantly, neither Dunfa (1998) nor Bogale and Urgessa (2012) assessed the WTP for a multiple-use scheme. Further research should check the extent to which location, access to extension and a greater willingness to pay are indeed a product of integrating both productive and domestic uses within a single water supply scheme.

5. Conclusion

This study has attempted to quantify and identify the factors that contribute to households being willing to pay for improving a specific multiple-use water scheme in Kersa District, Eastern Hararghe Zone, Oromia Region, Ethiopia. Our findings suggest it is necessary to explicitly consider gender issues when designing multiple-use schemes. This should focus on targeting female-headed households to relieve water-related labour burdens that crowd-out wider social reproductive and productive activities. Whilst our findings from the probit regression focus solely on female-headed households, and the voices of married women have not been included in the study, the findings still suggest that multiple-use schemes can bring meaningful benefits to women in all households: they can reduce labour burdens, reduce household morbidity and the associated time and financial costs. But the study has also highlighted how improved water supplies on their own will not bring many women or households meaningful benefits. If local institutional norms constrain the ability of women to access credit, this will stifle possible productivity gains. Moreover, without extension services, improved infrastructure, access to markets, and better storage facilities, the improvement of water supplies won't increase incomes to the extent they might. As all five livelihood capitals help to determine willingness to pay for a multiple-use scheme, an integrated approach to tackling each of these constraints would work best. The results also suggest that alongside an explicit gender focus, multiple-use schemes need to consider location differences seriously. The uniform application of water rates across peasant associations within a district may not be optimal.

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Notes

1. http://www.iwmi.cgiar.org.
2. Projects are normally small to avoid general equilibrium effects.
3. Kersa district is bordered by Dire Dawa administrative council to the north, Haramaya district to the east, Kurfachalle district to the south and Meta district to the west.
4. We checked for heteroskedasticity, multicollinearity and specification error using appropriate diagnostic tests and necessary corrections were taken before the regression analysis.
5. According to Hanemann, Loomis, and Kanninen (1991), the truncated mean WTP value can be calculated employing the following equation as specified by Hanemann et al. (1991):

$$E(WTP) = \ln\left(1 + e^{\beta 0}\right) / - \beta 1$$

That is, first the intercept and slope of bid will be estimated by regressing dependent variable ('yes' or 'no' response) on initial bid value, other explanatory variables held constant, and then these estimated coefficients will be replaced in the above formula to calculate the mean WTP value.

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