Willingness to pay and willingness to work for improvements of municipal and community-managed water services

William F. Vasquez-Mazariegos
Fairfield University, wvasquez@fairfield.edu

Published Citation
Vásquez, William F. "Willingness to pay and willingness to work for improvements of municipal and community-managed water services." Water Resources Research 50.10 (2014): 8002-8014. DOI: 10.1002/2014WR015913

Water Resources Research

RESEARCH ARTICLE

10.1002/2014WR015913

Key Points:

- Households with municipal services are willing to work for improved services
- Households with municipal services are willing to pay for improved services
- Households with community-managed services are unwilling to pay or work

Correspondence to:
W. F. Vásquez,
wvasquez@fairfield.edu

Citation:
Vásquez, W. F. (2014), Willingness to pay and willingness to work for improvements of municipal and community-managed water services, *Water Resour. Res.*, *50*, 8002–8014, doi:10.1002/2014WR015913.

Received 28 MAY 2014
Accepted 15 SEP 2014
Accepted article online 17 SEP 2014
Published online 16 OCT 2014

Willingness to pay and willingness to work for improvements of municipal and community-managed water services

William F. Vásquez[1]

[1]Department of Economics, Fairfield University, Fairfield, Connecticut, USA

Abstract This study investigates household preferences, in labor time and monetary terms, for improved water services in Guatemala using sequential contingent valuation questions. The household survey was implemented in areas served by municipal and community-managed systems, which allows for comparing household preferences under those governance approaches. Results show that respondents with municipal services are willing to pay a substantial increase (more than 200%) in their water bills for reliable supplies of safe drinking water. They are also willing to work approximately 19 h per month for such improved services when labor hours are proposed as the payment vehicle. In contrast, households with community-managed services are not willing to pay or work for service improvements, even though they report to be quite dissatisfied with current services. Policy implications are discussed.

1. Introduction

System improvements have become a priority to ensure continued provision of safe drinking water in many developing countries. Unreliable systems providing water that is often unsafe to drink represent a latent health risk. To mitigate that risk, many households expend a considerable amount of resources to treat tap water at home [*Pattanayak et al.*, 2005]. System unreliability also imposes considerable costs on households that cope with frequent service interruptions by investing in in-home water storage [*Pattanayak et al.*, 2005; *Vásquez*, 2012]. Those water practices may be less effective in mitigating health risks than expected given that some in-home storage devices facilitate recontamination of water after treating it [*Rangel et al.*, 2003; *Wright et al.*, 2004]. Improving water systems is therefore necessary but system revenues seem to be insufficient to operate and maintain water infrastructure and to adequately treat water for drinking purposes.

As noted by a number of earlier studies [e.g., *Griffin and Mjelde*, 2000; *Vásquez and Franceschi*, 2013], lack of information on local demand for improved services has been an impediment to the implementation of reliable, safe drinking supply systems in developing countries. Improved understanding of household preferences in the form of willingness to pay (WTP) for improved water services can inform pricing, affordability, and equity policies to help achieve cost recovery in the context of water system improvements. In response to the need of information on local demand for improved water services, contingent valuation (CV) studies have proliferated in the last decade to elicit household willingness to pay for improved water services in developing country contexts. *Kobel and Del Mistro* [2012] in Kampala (Uganda), *Perez-Pineda and Quintanilla-Armijo* [2013] in four semirural communities of El Salvador, and *Vásquez and Franceschi* [2013] in León (Nicaragua) provide recent examples of CV studies conducted in developing countries. Those studies provide evidence that households are willing to pay a significant amount for improved water services. However, concerns persist that cost recovery from consumer demand is not feasible in many developing areas [*Abramson et al.*, 2011].

Abramson et al. [2011] argue that analyses of willingness to work (WTW) for improved services can also help design appropriate policies for recovering operation and maintenance costs, particularly in rural areas where WTP tends to be lower and costs of provision are systematically higher. *Casiwan-Launio et al.* [2011], *Lankia et al.* [2014], and *Rai and Scarborough* [2012] present recent evidence suggesting that communities are willing to contribute with their labor to the management of forest and marine resources. WTW estimates can also be relevant for water systems, especially those systems that already depend on voluntary contributions of labor hours. Community-based water organizations (CBWOs), for instance, tend to rely on voluntary labor contributions for system operation and infrastructure maintenance, as well as for administrative endeavors such as collecting water fees. Despite being a promising approach for cost recovery in areas characterized by high poverty levels, household willingness to work for improved water services has received little attention in the literature until now.

This article investigates household preferences for improved water services in the small town of San Lorenzo, Guatemala using a contingent valuation survey. In addition to eliciting household preferences in monetary terms (i.e., willingness to pay), this study investigates household willingness to work for uninterrupted supplies of safe drinking water. *Vásquez* [2013a, 2013b] argues that the underlying structure of household preferences for water services may vary depending on the type of service governance due to differentials in service performance and institutional arrangements [also see *Vásquez and Franceschi*, 2013]. Hence, the CV survey was implemented in areas served by the municipality and CBWOs in order to compare household preferences under different governance approaches. Results indicate that household preferences are indeed different between municipal and community-managed systems. Households with municipal services are willing to pay a substantial increase in their water bills (more than 200% of the average water bill) for reliable supplies of safe drinking water. Those households are also willing to work approximately 19 h per month for improved services. In contrast, households with community-managed services are not willing to pay or work for service improvements despite being quite dissatisfied with current services.

The rest of this paper is organized as follows. Section 2 reviews the institutional framework and current condition of municipal and community-managed water systems in Guatemala and describes the study site. Section 3 shows the survey design, including the CV scenarios implemented to elicit the willingness to pay and work for improved water services. Section 4 introduces the analytical framework and econometric approach used to analyze the CV data. Section 5 presents survey and estimation results. Section 6 concludes the paper with a discussion of the results and some policy implications.

2. Drinking Water Services in Guatemala and Study Site

According to the Guatemalan constitution, as well as the municipal and health codes, municipalities are responsible for providing safe drinking water to all residents in their territorial jurisdiction. These laws also grant municipalities the right to transfer the management of water systems to private entities, which legitimizes the existence of CBWOs and private utilities in the country. The health code charges the Ministry of Public Health and Social Assistance (MSPAS, for its initials in Spanish) with regulatory and supervisory responsibilities to guarantee universal provision of safe drinking water in urban and rural areas. Water utilities, however, maintain total autonomy in setting water prices, operating water systems, and maintaining water infrastructure. In addition, the Institute of Municipal Development (INFOM, for its initials in Spanish) is mandated to support municipalities and CBWOs through investments in water infrastructure and development of technical and managerial capacities at the local level.

In practice, municipalities and CBWOs tend to be isolated with minimal governmental support because the institutional framework is fragmented and ambiguous [see *Ballestero et al*., 2005; *Vásquez*, 2011]. The existing legislation does not define clear relations among stakeholders (e.g., the central government, municipalities, nongovernmental organizations, and communities). Most community-managed systems are operated according to internal regulations and local traditions [*D'Andrea*, 2012]. This is not surprising given that the current legislation does not provide guidelines on how CBWOs should be formed or function, despite the relevance and long existence of CBWOs particularly in rural areas.

In accord to their legal mandate, municipalities are the main supplier of drinking water in urban areas reaching approximately 70% of urban households as of 2011 [*Vásquez*, 2014]. In contrast, municipalities have failed to extend their water services to rural areas where only 15% of the households receive municipal water services. CBWOs have emerged, in an organic way, as primary providers of water in rural areas serving about 40% of rural households. Both municipal and community-managed services are frequently interrupted [*Vásquez*, 2014]. In addition, there are growing concerns regarding the quality of drinking water. Several studies have reported that water sources are contaminated in urban and rural areas representing a significant health risk at the national level [e.g., *Galindo and Molina*, 2007; *Instituto de Agricultura, Recursos Naturales y Ambiente*, 2005; *Vásquez*, 2013c]. In order to improve the quality of water services, MSPAS has recently issued a number of ministerial agreements that regulate system operations, including treatment methods. Those agreements also provide specific standards of water quality that all water utilities are expected to fulfil in 2014. Although well intentioned, these requirements will impose inherent costs on municipalities and CBWOs that currently seem unable to raise enough revenues to provide reliable drinking water services to their communities.

Water systems in our study site, San Lorenzo, provide an example of unreliable services that will require significant improvements, if safe drinking water is to be provided. San Lorenzo is a small town with approximately 10,000 inhabitants, of which 90% live in rural areas. A total of 10 CBWOs provide water services in the rural areas and the municipality serves the urban center to reach approximately 76% of San Lorenzo's inhabitants [*Instituto Nacional de Estadística (INE)*, 2002]. Those water services, however, are frequently interrupted. The municipality and CBWOs also fail in implementing periodic water testing so there is no guarantee that piped water is safe to drink. Funding service improvements may be a challenge for the municipality of San Lorenzo and CBWOs given the prevalent poverty in the area. *Secretaría de Planificación y Programación de la Presidencia and Instituto Nacional de Estadística* [2006] estimate that 83.5% of San Lorenzo's inhabitants live below the national poverty line. Moreover, extreme poverty is estimated at 32.6% (The national poverty lines are based on household consumption [see *INE*, 2006]. The extreme poverty line is established at 3206 quetzals (U.S. $ 414), and the nonextreme poverty line is at 6574 quetzals (U.S. $ 848)). The extreme poverty level in San Lorenzo is considerably higher than the national average of 13%. Poverty indicators are consistent with emigration patterns in the area. The 2002 national census indicates that 12.6% of the households in San Lorenzo reported that at least one member of the household had emigrated in the 1990s [*INE*, 2002].

In this context of high poverty and population mobility, CBWOs may find it difficult to raise enough resources to improve water infrastructure and to operate and maintain improved systems given their dependency on water fees and voluntary inputs provided by the community. CBWOs tend to be ineffective in collecting the flat rate they charge for their services. Payment enforcement mechanisms are limited to general reminders to their constituents in periodical community meetings that they should pay their water bill. In addition, CBWOs do not require households to provide labor inputs on a regular basis, so the responsibility for operating the water system lies exclusively on a few CBWO members. The municipality also seems to struggle in collecting revenues to improve the quality of its services, despite charging a volumetric tariff for water services. In 2010, the town had revenues of 8.35 million quetzals (about $1.08 million U.S. dollars) of which less than 11% was locally generated through taxes and service fees. This ranks San Lorenzo among the municipalities with least capacity to generate local revenues in the state of San Marcos [*Fundación Centroamericana De Desarrollo (FUNCEDE)*, 2011].

Municipalities and CBWOs can be expected to face difficulties in improving their water services in towns with high levels of poverty such as San Lorenzo. Under these circumstances, it is necessary to investigate the financial feasibility and sustainability of service improvements. One step in this process is the analysis of households' willingness to pay for service improvements. Given that CBWOs partially depend on voluntary contributions of labor, it is also appropriate to explore households' willingness to work on managing, operating, and maintaining improved water systems. Information on household preferences for improved services may provide important inputs to the planning process of municipal and community-managed water systems.

3. Survey Design

A household survey was carefully designed to gather information on household preferences for improved water services. The survey design included one-on-one semistructured conversations and focus groups with local residents implemented through different iterations in order to incorporate feedback. The questionnaire was pretested through a pilot survey implemented by trained interviewers (local residents) with a random sample of 30 households. The final survey instrument was administered through in-person interviews to a random sample of 500 households in June–August 2012. It is estimated that San Lorenzo has more than 1500 housing units. However, municipal housing records are not updated, particularly for rural areas. Therefore, a simple protocol was implemented to select 500 households. In order to identify the next house to be interviewed, interviewers were instructed to generate a random number in the field. Appointments were arranged with sampled households that did not have time to respond the questionnaire in the first visit. Interviewers were instructed to replace a few households that could not be interviewed after a second visit. Out of the 500 households interviewed, 37.2% received water from the municipal system and the rest was served by CBWOs.

The survey questionnaire was divided into four sections. The first section collected information regarding service performance and household practices. The second section asked respondents to report their satisfaction with different service characteristics (i.e., service hours, water pressure, water quality, and water fees) using a four-tiered scale ranging from "very satisfied" to "very unsatisfied." The third section included the CV questions used to estimate households' WTP and WTW for improved water services. The final section elicited respondents' sociodemographic information and household characteristics.

Despite multiple criticisms, CV surveys have evolved to be one of the most viable methods of collecting household preference data with regards to public goods and services [*Carson*, 2012; *Carson et al*., 2001; *Champ et al*., 2003]. Choice experiments can also be used to investigate marginal values of service attributes in labor-hour and monetary terms [e.g., *Abramson et al*., 2011; *Rai and Scarborough*, 2012]. However, choice experiments demand significant cognitive skills from respondents, which may complicate their application in contexts of low education and lack of experience choosing among policy options, as our study site [see *Hanley et al*., 2010]. Alternatively, sequential CV questions can yield stated preference data that is consistent with choice experiments [see *Christie and Azevedo*, 2009]. There is also evidence that CV questions and choice experiments yield similar WTP estimates [e.g., *Loomis and Santiago*, 2013]. Therefore, two sequential contingent valuation questions were designed using a referendum format in order to elicit households' willingness to pay and work for improved water services (i.e., uninterrupted supply of safe drinking water). Respondents are familiar with referendum questions given that political elections have been implemented in the town of San Lorenzo for more than three decades [*FUNCEDE*, 2011].

The CV scenarios were designed to value an improvement of current water systems in order to ensure continued supply of safe drinking water, in accord with the regulations that MSPAS has recently issued. The first referendum question begins with a description of current water services. Then, the CV scenario introduces a project that will improve current water services in order to supply safe drinking water without service interruptions. Respondents are informed that they would have to pay an additional fee for the improved service if the project is approved. The additional fee was randomly varied across respondents from 10 to 50 quetzals in increments of 10 quetzals. In addition, respondents are confronted with their budget constraint through a reminder that the additional fee paid for improved services is money forgone in the consumption of other goods. Finally, respondents are given the opportunity to vote for or against the project. The (translated) referendum-format CV question presented in the survey reads as follows:

> For the following question, please keep in mind that current water supplies are frequently interrupted and that piped water may be unsafe to drink. Suppose that the residents of your community will have the opportunity to vote for or against a project that would improve the current water system. With this new system, your house will have piped water 24 h a day, all days of the year. In addition, the water would be purified to make it totally safe to drink. If the project is approved, your home would have to pay an increase of **[10/20/30/40/50]** quetzals in your monthly water bill, in addition to your present payment. Please keep in mind that, if you decide to pay this amount in your monthly water bill, you will not be able to use that money to buy food, clothes, and other things necessary to your home.
>
> Would you Vote For or Against the project?
>
> ___ **Yes** (for the project) ___**No** (against the project)

In the follow-up CV question, respondents were confronted with a slightly different project in order to investigate their willingness to work for improved services. The proposed project is similar in that it offers uninterrupted service of totally safe drinking water. However, the payment vehicle is changed from a monetary fee to a (nonmonetary) contribution of labor hours to operate, maintain, and manage the improved water system. *Ahlheim et al*. [2010] argue that labor should not be used as a payment vehicle in contingent valuation studies because labor cannot be converted into utility as easily as money. However, in areas with subsistence economies, housework may be the primary vehicle to obtain goods that increase households' utility. *Ahlheim et al*. also indicate that empirical estimates of willingness to work depend on the kind of labor to be done and the circumstances under which it has to be provided. Careful design of contingent scenarios in which the tasks to be performed as part of the proposed program are clearly defined can help overcome this limitation. Similarly to the willingness-to-pay question, the willingness-to-work question reminded respondents that the labor hours allocated to operating and maintaining the water system would not be available for paid work or other household activities. The translated referendum-format CV question presented in the survey is as follows:

> Suppose again that you have the opportunity to vote for or against a project that will provide you totally safe drinking water 24 h a day, every day of the year. However, rather than paying an increase in your water bill, an adult member of your household will have to work **[4/8/12/16/20/24]** hours per month in managing, operating, and maintaining the water system. Keep in mind that this household member will not be able to work or to do other household chores while working on the water project.
>
> Would you Vote For or Against the project?
>
> __ **Yes** (for the project) ___**No** (against the project)

The number of hours that a household member would have to work in exchange for improved services were randomly varied across respondents from 4 to 24 h in increments of 4 h. The additional fee and the number of labor hours presented in the CV questions were calibrated in the focus groups.

4. Analytical Framework and Econometric Modeling

The empirical analysis of household preferences for improved water services conducted here is based on a utility-theoretic framework. The discussion of this framework is kept to a minimum given that similar theoretical models have been presented elsewhere. *Eom and Larson* [2006], for instance, developed a utility-theoretic framework to analyze households' willingness to pay and work for environmental quality improvements. In Eom and Larson's model, households are assumed to derive utility from consumption of goods and services, leisure, housework as needed for household maintenance, and a nonmarket good such as drinking water. Households choose the levels of consumption, leisure, and housework in order to maximize their utility subject to budget and time constraints. As a result, the (indirect) utility (V) can be expressed as a function of the full prices of consumption goods (P_f), a full budget (M_f), and the quality of drinking water services (W), as well as household characteristics (Z). The full prices of consumption and leisure include both money prices and the market value of time for those activities. The full price of housework also includes the money price and the time value for this activity. However, the value of housework time is lower than the value of other time (i.e. time for leisure and consumption) because, even though housework has some marginal utility, the household would prefer to have to do less of it. The full budget includes the money budget and the time constraints monetized at their shadow values.

The utility-theoretic framework predicts that households will be willing to pay or work for water service improvements up to the extent that this payment does not decrease their utility below the original utility level. Thus, a household's maximum willingness to pay or willingness to work can be stated as follows:

$$V(M_f, P_f, W_0, Z) = V(M_f - WTP, P_f, W_1, Z) = V(M_f - \psi WTW, P_f, W_1, Z) \quad (1)$$

where W_0 represents the current quality of water services, W_1 represents improved water services under the proposed project (i.e. uninterrupted supply of safe drinking water), and ψ is the value of saving housework time. The underlying assumption in *Eom and Larson's* [2006] model is that the household will take labor hours from housework rather than from leisure time in order to pay for improved water services. This implies that the number of hours that the household is willing to work for improved services should not be valued at market wages, as the value of labor time is assumed to be higher than the value of housework time.

In the empirical analysis, the willingness to pay and willingness to work for improved water services is assumed to follow a log-linear specification:

$$LNWTP_i = X'_i\beta + u_i \quad (2)$$

$$LNWTW_i = X'_i\delta + v_i \quad (3)$$

where *LNWTP* stands for the natural logarithm of household *i*'s willingness to pay for improved water services, *LNWTW* represents the natural logarithm of household *i*'s willingness to work for improved water services, X is a vector of covariates, β and δ are conformable vectors of relevant coefficients to be estimated, and u and v are stochastic error terms. Since the error terms for the *LNWTP* and *LNWTW* functions are likely to be correlated, u and v are assumed to follow a normal distribution with different scale parameters (σ_u^2 and σ_v^2, respectively) and correlation parameter ρ_{uv} [i.e., $N(0, 0, \sigma_u^2, \sigma_v^2, \rho_{uv})$].

In the referendum format, households' willingness to pay and willingness to work for the proposed improvement are not directly observed. It is expected that responses to the referendum question with the monetary payment vehicle will be favorable (i.e., R_m = Yes) only if *LNWTP* is greater than or equal to the natural logarithm of the monetary fee ($LNBID_m$) presented to the respondent. Similarly, when the labor time is assumed to be the payment vehicle, the respondent will vote for the proposed project (i.e., R_t = Yes) only if *LNWTW* is greater than or equal to the natural logarithm of the labor time presented to the respondent ($LNBID_t$) in the CV scenario. Otherwise, the respondent is expected to vote against the project. This implies that the probabilities of favorable responses to the CV questions are equivalent to the probabilities that willingness to pay and willingness to work are greater than the corresponding bids proposed in those questions [i.e. P(R_m = Yes) = P($LNWTP > LNBID_m$) and P(R_t = Yes) = P($LNWTW > LNBID_t$)]. Therefore, the probabilities of favorable responses, P(R_m = Yes) and P(R_t = Yes) are jointly estimated using bivariate probit models that allows the error terms u and v to be correlated (see *Greene* [2012] for a thorough review of bivariate probit models.).

The bivariate probit models of WTP and WTW include the same covariates with the exception of the natural logarithm of the monetary bid, which is included only in the WTP model, and the natural logarithm of the labor hours that is included only in the WTW model. The likelihood of positive responses to the CV questions is expected to decrease with the bids presented to the respondent in the CV scenarios. The vector of covariates (X) also includes indicators on system unreliability and water pressure. Households with more frequent service interruptions are expected to be more likely to vote in favor of the proposed project because they can perceive a larger improvement in water services. Conversely, the likelihood of positive responses is expected to decrease with higher levels of water pressure. Similarly, households that are more satisfied with current services are expected to be less likely to vote for the proposed projects as they would perceive smaller service improvements.

Additionally, household income and remittances are used as covariates to represent the full budget that constrains household decisions in the theoretical model. As levels of income and remittances rise, some constraints on household choices relax. Thus, richer households are expected to be more likely to vote in favor of the proposed project. Household size is also used as a covariate, although no prior expectations are held on the sign of its coefficient. The likelihood of voting in favor of the proposed project can be expected to increase with household size because a larger number of individuals will benefit from the proposed project. However, from a theoretical perspective, the effect of household size can be negative because freely disposable income decreases with the number of household members [see *Ahlheim and Schneider*, 2013]. Therefore, the effect of household size, as well as effects of other household and individual characteristics included to control for household heterogeneity, remain to be empirically estimated.

5. Survey and Estimation Results

The subsamples of respondents with municipal and community-managed water systems show some similarities but also differences particularly in education and economic status. Table 1 shows that approximately 72% of the respondents were females, presumably because interviews were held during working hours when males are more likely to be out of home. The average respondent in both samples is older than 40 years of age, lives in a household with almost six members, and has lived in their current home for about 20 years. Given that respondents have lived in their current housing unit for a long time, it can be expected that they are quite familiar with the quality of water services in the study site. The average respondent with municipal services has more than 8 years of schooling. In contrast, the average respondent with community-managed services shows a lower level of education with about 3 years of schooling less than respondents with municipal services. A similar pattern is observed in household income and remittances. The municipal subsample of respondents earns almost six times more income than respondents with community-managed services, and receives almost five times more remittances as well. A vast majority of respondents own their homes, although there are more households renting their homes in the area covered by municipal services than in the area with community-managed services (10.9 versus 3%, respectively).

Table 1. Sample Characteristics[a]

	Community	Municipal	Mean Comparison Tests
Age	40.288	42.470	t = 1.499
	(14.984)	(15.341)	
Years of schooling	4.727	8.141	t = 8.378***
	(4.217)	(4.281)	
Female respondents (%)	72.7%	71.2%	χ^2 = 0.126
	(44.6%)	(45.4%)	
Household size	5.792	5.554	t = 1.042
	(2.427)	(2.290)	
Years living in current housing unit	20.775	19.884	t = 0.685
	(13.495)	(13.541)	
House owners (%)	97.0%	89.1%	χ^2 = 11.372***
	(17.2%)	(31.2%)	
Income per month (quetzals)	422.35	2,391.30	t = 16.450***
	(853.15)	(1,692.90)	
Remittances per month (quetzals)	113.64	551.63	t = 7.429***
	(361.98)	(883.91)	

[a]Notes: ***, **, * imply significance at 1, 5, and 10% levels, respectively; numbers in parentheses are corresponding standard errors.

The municipal system outperforms the community-managed systems in terms of service reliability. Table 2 shows that services provided by CBWOs are interrupted more frequently than municipal services. On average, community-managed services are interrupted at least 3 h in about 4 days in a week, with the longest interruptions lasting almost an entire day. Municipal services are interrupted approximately 1 day per week, with the longest interruptions lasting less than 6 h. In addition to being more frequently interrupted, community-managed systems also seem to provide water with less pressure than the municipal system (see Table 2). Despite providing more unreliable services, CBWOs charge higher water fees than the municipal system with an average difference of 7.37 quetzals per month (almost 1 U.S. dollar). At first glance, this differential in water bills may be surprising because CBWOs are supposed to face lower costs than municipal systems given that water users provide voluntary inputs to operate and maintain community-managed systems. However, the municipality may be able to provide their services at a subsidized price because it receives financial transfers from the central government. CBWOs, on the other hand, receive minimal and sporadic governmental support to manage their systems, if any.

Figure 1 shows the reported levels of satisfaction with service hours, water pressure, treatment, and price from respondents with municipal and community-managed water services. Overall, respondents with municipal services report higher levels of satisfaction than respondents served by CBWOs. Differentials in satisfaction levels are all statistically significant based on χ^2 tests reported in Figure 1. A vast majority of respondents served by the municipal system are satisfied with water prices, treatment, pressure, and service hours. In contrast, a majority of respondents with community-managed services are unsatisfied with water prices, water pressure, and service hours. Water treatment is the only characteristic that satisfies a majority of respondents with community-managed services, although that percentage remains below the percentage of respondents with municipal services that is satisfied with current water treatment (54.2 versus 64%, respectively). Reported satisfaction levels suggest that current community-managed services are not responsive to user preferences and that a latent desire for improved water services exists in the community. On the other hand, households with municipal services are satisfied with current water services, although some gains could be expected from improving current water treatment.

Table 2. Characteristics of Water Services[a]

	Community	Municipal	Mean Comparison Tests
Days per week with service interruptions	3.735	0.848	t = 19.694***
	(1.607)	(1.402)	
Hours of longest service interruption	21.593	5.815	t = 19.949***
	(7.009)	(9.713)	
Hours of shortest service interruption	3.268	0.402	t = 5.422***
	(0.402)	(1.928)	
Monthly water bill (in quetzals)	24.40	17.17	t = 7.532***
	(11.982)	(6.105)	
Households reporting low pressure (%)	32.3%	11.4%	χ^2 = 84.737***
	(46.8%)	(31.9%)	

[a]Notes: ***, **, * imply significance at 1, 5, and 10% levels, respectively; numbers in parentheses are corresponding standard errors.

Following *Vásquez and Trudeau* [2011], the internal consistency of reported levels of satisfaction with daily service hours, water pressure, treatment, and price was assessed using factor analysis (see Table 3). Estimated factor loadings show a considerable association between reported levels of satisfaction with specific service characteristics and a latent single scale, namely overall satisfaction.

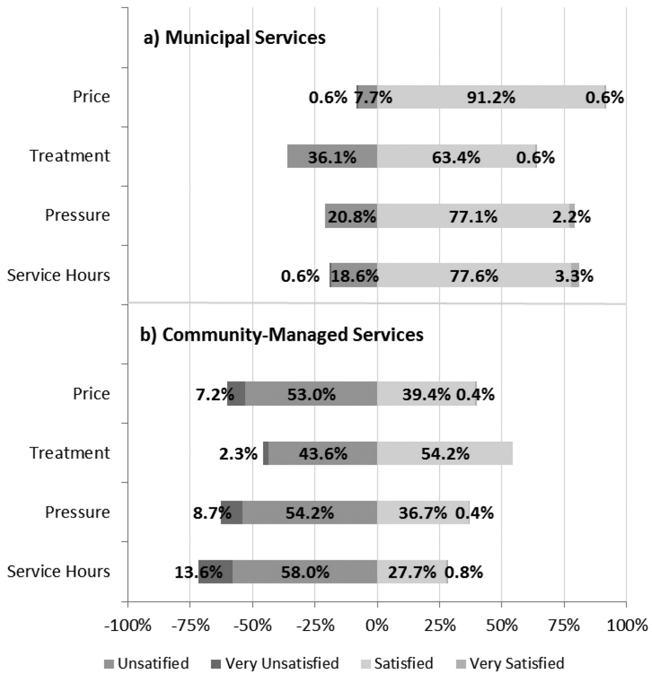

Figure 1. Consumer satisfaction with current water services. Notes: positive percentages indicate satisfaction with water service attributes; negative percentages indicate dissatisfaction. $\chi 2$ tests indicate that satisfaction levels are statistically different between the subsamples of households with municipal and community-managed services: $\chi 2 = 121.88$ for price, $\chi 2 = 8.69$ for treatment, $\chi 2 = 81.86$ for pressure, and $\chi 2 = 122.32$ for service hours.

Water treatment and price show the lowest factor loadings (i.e., association with the single satisfaction scale). The Kaiser-Meyer-Olkin (KMO) statistics are above the critical level of 0.5 indicating that the degree of common variance among reported satisfaction with daily service hours, water pressure, treatment, and price is acceptable to conduct a factor analysis [see *Kaiser and Rice*, 1974]. Therefore, all four service characteristics are used to estimate a standardized index of satisfaction that is included as a covariate in WTP and WTW probit models.

5.1. Preferences of Households With Municipal Services

Households' willingness to pay and willingness to work for improved services are investigated through a number of probit and bivariate probit models of responses to the sequential referendum CV questions presented above (see *Gunatilake and Tachiiri* [2012] and *Van Hecken et al*. [2012] for recent applications of probit and bivariate probit models used to investigate the willingness to pay for improved water services.). A likelihood ratio test ($\chi^2 = 220.46$) indicates that estimated coefficients for bivariate probit models are different across subsamples of households with municipal and community-managed services. This suggests that household preference structures are different between those service governance approaches. Hence, models of willingness to pay and willingness to work were estimated for each subsample. Table 4 shows that the correlation estimate ($\rho = 0.518$, $p = 0.001$) is statistically significant indicating that the models of willingness to pay and willingness to work are related to each other through unobserved factors. Therefore, the bivariate probit model estimated here is suitable to analyze the preferences of households with municipal services.

As expected, estimation results indicate that respondents are sensitive to water prices and to the number of hours that they would have to work in order to receive improved water services (see Table 4). In the WTP model, the estimated coefficient on the natural log of the bid is negative and statistically significant. This implies that the choice probability of voting for the project decreases with increases in the water bill proposed to fund the operation and maintenance of the improved system. Findings also indicate that households that receive services with better water pressure are less likely to vote in favor of system improvements as indicated by the negative sign and statistical significance of corresponding coefficients. Those households may perceive fewer benefits from improving the system than households that receive services with low water pressure and, therefore, are less likely to support the project.

Table 3. Factor Analysis of Consumer Satisfaction[a]

	Loadings	KMO
Service hours per day	0.931	0.578
Water pressure	0.966	0.577
Water treatment	0.589	0.639
Water price	0.558	0.909
Single Satisfaction Scale	—	0.6245

[a]Notes: the eigenvalue for the first factor is 2.458. For other factors, Eigen values are less than one.

Respondent's age is the only personal characteristic that seems to be associated with the WTP for improved services. The choice probability of voting for the project decreases with the age of the respondent. *Vásquez and Franceschi* [2013] also found a negative relationship between age and WTP for improved water services in Nicaragua. They argue that older individuals may be used to low service quality and that they may downplay their expectations for water service improvements as a result of

10.1002/2014WR015913

Table 4. Biprobit Models of Willingness to Pay and Willingness to Work for Improved Municipal Water Services (Marginal Effects)[a]

Variables	WTP	WTW	Variable Mean
Natural logarithm of the bid	−0.494 (0.075)***	—	3.227
Natural logarithm of the labor hours	—	−0.259 (0.071)***	2.465
Days per week with service interruptions	−0.071 (0.051)	−0.033 (0.060)	0.859
Regular water pressure (1=Yes; 0=Otherwise) (base = low pressure)	−0.265 (0.159)*	−0.087 (0.162)	0.333
High water pressure (1=Yes; 0=Otherwise) (base = low pressure)	−0.312 (0.138)**	−0.040 (0.186)	0.554
Monthly household income (in 1000's quetzals)	0.009 (0.024)	−0.015 (0.030)	2.853
Monthly remittances (in 1000's quetzals)	0.025 (0.034)	0.020 (0.038)	0.763
Standardized index of satisfaction	−0.019 (0.084)	−0.168 (0.106)	0.545
Years living in current housing unit	−0.0003 (0.003)	0.004 (0.004)	20.257
Household size	0.028 (0.017)	0.051 (0.021)**	5.604
If the household owns the housing unit (1=Yes; 0=Otherwise)	−0.010 (0.121)	−0.131 (0.149)	0.898
If the respondent is female (1=Yes; 0=Otherwise)	0.054 (0.086)	0.136 (0.095)	0.717
Respondent's age	−0.009 (0.004)**	−0.015 (0.005)***	42.508
Respondent's education	−0.008 (0.013)	−0.027 (0.017)	8.107
Observations	177		
Rho	0.518***		

[a]Notes: ***, **, * imply significance at 1, 5, and 10% levels, respectively; numbers in parentheses are corresponding standard errors. Marginal effects are computed at the mean values of independent variables.

their longer exposure to unreliable services. It could also be that, compared to younger respondents, older individuals may expect a shorter future lifespan to enjoy the benefits from an improved water system. Thus, the lower levels of support to the proposed project found among older respondents may reflect lower discounted benefits relative to younger individuals. Other factors are found to be statistically insignificant suggesting that they have little influence in the decision to support the proposed project. The insignificance of household income is particularly unexpected because economic theory suggests that income constraints play an important role in households' decision for paying for improved water services. It can be argued, however, that the bids presented in the initial contingent scenario (10–50 quetzals per month) are low relative to household income (2391 quetzals per month, on average). That is, income is not a binding constraint for improving municipal water services.

The median WTP can be computed from the same probit coefficients that were used to derive the marginal effects reported in Table 4. The median WTP is estimated as $\exp(-X_{NONBID}{}^{*}\ \beta_{NONBID}/\beta_{LNBID})$ where X_{NONBID} is the vector of averages of variables used to estimate the bivariate probit model (see Table 4) with the exception of the natural logarithm of the bid. β_{LNBID} represents the estimated coefficient of the natural logarithm of the bid and β_{NONBID} represents the vector of estimated coefficients of corresponding covariates other than the bid. Also, 95% confidence intervals of the median WTP are estimated using the delta method, which is suitable to compute the variance of nonlinear combinations of estimated coefficients [see *Hole*, 2007 for a detailed description of the delta method].

The estimated median willingness to pay is 36.20 quetzals (about 4.65 U.S. dollars), with a 95% confidence interval of 26.93–45.47 quetzals. This implies an increase in the average monthly water bill of more than 200%, equivalent to 1.5% of the average household income. If the municipality increases the average water bill by 36.20 quetzals (up to 53.37 quetzals), the total household expenditure on tap water would be 2.2% of the average household income, which is below the internationally-accepted affordability threshold for water services of 3% of household income [*Organization for Economic Co-operation and Development (OECD)*, 2003]. The WTP for improved municipal water services in San Lorenzo is also below WTP estimates from neighbor countries. *Vásquez and Franceschi* [2013], for instance, found that the median household in León, Nicaragua is willing to pay over 8% of its income for reliable drinking water services. *Vásquez et al.* [2009] report a WTP estimate of almost 6% of the average household income in Parral, Mexico.

Respondents served by municipal services are also responsive to the number of hours that households would have to work in order to receive improved water services (see the WTW model in Table 4). As expected, the corresponding coefficient is negative and significant suggesting that the choice probability of voting for the project decreases with the number of hours that they would have to work in exchange for improved services. Larger households seem to lend more support to the proposed project than smaller households. Households with more members have a larger number of labor hours available that can be used to pay for the proposed improvement in water services. In addition, the estimated coefficient on

Table 5. Probit Models of Willingness to Pay and Willingness to Work for Improved Communal Water Services (Marginal Effects)[a]

Variables	WTP	WTW	Variable Mean
Natural logarithm of the bid	−0.159 (0.055)***	–	3.228
Natural logarithm of the labor hours	—	−0.013 (0.053)	2.465
Days per week with service interruptions	0.035 (0.020)*	−0.074 (0.023)	3.750
Regular water pressure (1=Yes; 0=Otherwise) (base = low pressure)	−0.086 (0.066)	−0.055 (0.071)	0.531
High water pressure (1=Yes; 0=Otherwise) (base = low pressure)	−0.011 (0.087)	−0.064 (0.101)	0.146
Monthly household income (in 1000's quetzals)	0.096 (0.040)**	0.049 (0.033)	0.573
Monthly remittances (in 1000's quetzals)	0.082 (0.079)	0.247 (0.101)**	0.177
Standardized index of satisfaction	−0.067 (0.031)**	−0.072 (0.034)**	−0.426
Years living in current housing unit	−0.002 (0.003)	0.001 (0.003)	20.754
Household size	0.015 (0.011)	0.009 (0.013)**	5.781
If the household owns the housing unit (1=Yes; 0=Otherwise)	0.029 (0.153)	0.008 (0.175)	0.969
If the respondent is female (1=Yes; 0=Otherwise)	0.058 (0.074)	0.008 (0.073)	0.731
Respondent's age	0.003 (0.003)	0.002 (0.003)	40.392
Respondent's education	0.028 (0.009)***	0.005 (0.010)	4.709
Observations	260	260	
Pseudo R^2	0.187	0.1563	

[a]Notes: ***, **, * imply significance at 1, 5, and 10% levels, respectively; numbers in parentheses are corresponding standard errors. Marginal effects are computed at the mean values of independent variables.

respondents' age is negative and significant, similarly to the WTP model. Other factors are found to be statistically insignificant.

The WTW model is also used to estimate the households' willingness to work for improved water services. The median WTW is estimated at 18.9 h per month, with a 95% confidence interval of 7.2–30.5 h per month. The hourly wage for unskilled labor in the municipality is about 10 quetzals. If a similar wage were to be paid for working in system operation and maintenance, the WTW estimate would be equivalent to 189 quetzals per month or more than 500% of the estimated WTP. *Abramson et al*. [2011] also found that households are willing to work for improved access to water in rural Zambia, and that the monetary value of their WTW surpasses their WTP when time is valued at market wages. However, they argue that households would reallocate housework time to work for improved services (rather than leisure time) and that the value that households assign to housework time is lower than wages paid in labor markets. Under the assumption that households would reallocate housework time to work for improved water services, a comparison of our WTP and WTW estimates (36.20 quetzals and 18.9 h, respectively) suggests that housework time is valued at approximately 2 quetzals per hour, which is equivalent to 20% of market wages.

5.2. Preferences of Households With Community-Managed Services

Bivariate probit models were also estimated to investigate the preferences of households with community-managed systems. Nevertheless, the correlation estimate was found to be statistically insignificant ($\rho = -0.081$, $p = 0.5$). Hence, Table 5 shows separate probit models of willingness to pay and willingness to work for the subsample of households with community-managed services as there is no gain in allowing the error terms to be correlated. Results from the WTP probit model suggest that respondents are responsive to the bid presented in the contingent scenario, lending less support to the proposed project when water bills are increased by a larger amount. On the other hand, households experiencing frequent service interruptions are more likely to vote in favor of the project than households with fewer interruptions, most probably because they perceive more benefits from the proposed project. More affluent households are also more likely to vote in favor of the project. This income effect was found to be statistically insignificant for the subsample of households with municipal services arguably because they have higher income levels relative to their willingness to pay and thus income is not binding their decision to support the project. On the other hand, households with community-managed services may be constrained due to the low levels of their household income.

Additionally, the satisfaction index is found to be negative and statistically significant (at 5% level) indicating that respondents who are unsatisfied with current water services are more likely to vote in favor of system improvements. The estimated coefficient on respondents' education suggests that the choice probability of voting for the project increases with years of schooling. Awareness of the benefits derived from improving water services can increase with education, which may explain why respondent with higher

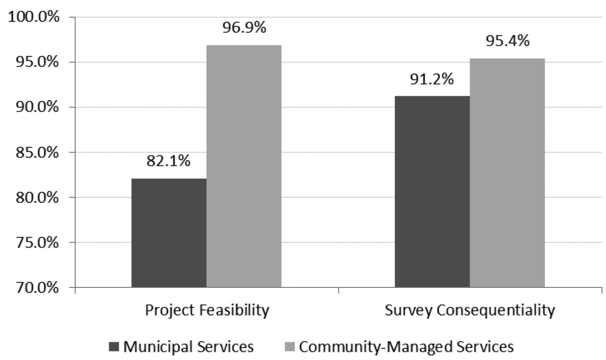

Figure 2. Survey quality indicators.

levels of education are willing to pay more for service improvements [*Arouna and Dabbert*, 2012]. Other factors do not seem to impact the respondents' willingness to pay for improved services.

The preference structure of households with community-managed services is different when the payment method is labor hours instead of monetary fees (see Table 5). Contrary to expectations and to the results from the subsample of households with municipal services, the amount of work hours is not a determinant of the decision to support the proposed project. In contrast, remittances, satisfaction with current services, and household size affect the choice probability of voting in favor of the proposed project. The likelihood of supporting the project increases with remittances presumably because remittances can relax some constraints allowing the recipient household to allocate more labor hours to operation and maintenance of the improved system. Similar to the project with a monetary payment vehicle, satisfaction levels have a negative effect on the choice probability of voting for the project that would require them to work in exchange of improved services. In addition, the likelihood of voting for the project increases with number of household members, an effect that is consistent across subsamples of households served by the municipality and CBWOs.

The probit models presented in Table 5 are used to estimate the median willingness to pay and the median willingness to work for improved services. Those estimates are found to be statistically insignificant suggesting that households with community-managed services are not willing to pay or work for the proposed improvements. For community-managed services, the median WTP is estimated at 181.29 quetzals, with a 95% confidence interval of −89.87 to 452.39 quetzals. The median WTW cannot be computed because the coefficient of the (log) labor hours is statistically equal to zero. This is somewhat unexpected given that a majority of respondents with community-managed services demonstrate to be dissatisfied with those services. The lack of willingness to pay or work for improved services may be an obstacle for CBWOs that intend to improve their water services.

The survey included some questions to assess the credibility of the contingent scenarios used in this study. A vast majority of respondents believe that it is feasible to implement the proposed project, particularly in those areas served by CBWOs (see Figure 2). In addition, more than 90% of respondents believe that survey results may have policy consequences on the quality of water services. These results suggest that respondents found the contingent scenarios to be credible, thus lending further support to the validity of WTP and WTW estimates presented above.

Models presented in Tables 4 and 5 were estimated excluding the satisfaction index to investigate potential multicollinearity issues in estimated coefficients, particularly due to potential correlation between the standardized index of satisfaction and water service characteristics (service interruptions and water pressure). Results are robust in terms of sign and significance of estimated coefficients. Variance inflation factors (computed for all covariates in Tables 4 and 5) are within an acceptable range of 1.01–2.35, with an average of 1.60. This provides further evidence that estimation results presented in Tables 4 and 5 are robust.

6. Discussion and Policy Implications

This study investigated household preferences, in labor time and monetary terms, for improved water services in the small town of San Lorenzo, Guatemala. The analysis was conducted in areas served by the municipality and CBWOs to compare household preferences under those governance approaches. Findings indicate that respondents with municipal services are willing to pay a substantial increase in their water bills (more than 200% of the average water bill) for a reliable supply of safe drinking water. They are also willing to work approximately 19 h per month for improved services when labor hours are proposed as payment vehicle. Conversely, respondents with community-managed services are not willing to pay or work for service improvements, even though they report to be quite dissatisfied with current services. These findings are consistent with previous studies that indicate that households value municipal water services, but do not value community-managed services in Guatemala [*Vásquez*, 2013a, 2013b].

It could be argued that households served by CBWOs are used to low-quality services and, consequently, they are not willing to pay or work for improved services. However, those households report low levels of satisfaction with different attributes of the water supplied, and satisfaction was found to be negatively related to the likelihood of voting in favor of the proposed projects. This lends little support to the hypothesis that they do not consider service improvements to be needed in their communities. Moreover, a vast majority of households served by CBWOs believe that it is feasible to implement the proposed project in their community, and that survey results may be consequential for policy purposes. These results rule out the possibility that households with community-managed systems show a low willingness to pay or work because they are skeptical about the project presented in contingent scenarios.

A more plausible explanation could be that the lack of willingness to pay for improved services is a reflection of households' inability to pay given that household income is a determinant of the likelihood of voting in favor of the proposed project. On average, households with community-managed services already pay approximately 5.8% of their household income (4.6% if remittances are included), which is above the internationally-accepted affordability threshold of 3% [*OECD*, 2003]. Moreover, households served by CBWOs may be aware that they already pay higher water bills for services that are interrupted more frequently in comparison to their neighbors with municipal services. This may create distorted perceptions among households with community-managed services, that current water fees are already high enough to recover operation and maintenance costs, and perhaps to finance service improvements. As a result, those households are not willing to pay an increase in their water bills for improved water services.

A potential limitation of this study is that protesters and yea-sayers were not identified in the survey instrument, although focus groups participants seemed to base their voting decisions on budget constraints. Protesters can introduce a downward bias into WTP and WTW estimates because they reject the proposed project even though they would be willing to pay for service improvements. It is worth noting that, in the context of this study, particularly in community-managed systems, protesters can actually decide not to pay any increase in water bills given that CBWOs lack mechanisms to enforce water bill payments. Under those circumstances, the inclusion of protesters would yield a lower bound estimate of willingness to pay that is arguably more consistent with increases in water bills that water utilities could actually collect for service improvements. Respondents could also vote in favor of the project even if they are not willing to pay for improved services (i.e. yea-saying). The presence of those respondents may lead to overestimating households' willingness to pay for improved services. WTP estimates presented in this study are lower than estimates presented by previous studies conducted in similar contexts [e.g., *Vásquez et al.*, 2009; *Vásquez and Franceschi*, 2013] and the internationally-accepted affordability threshold for water services of 3% of household income. This suggests that, even if our estimates are upwardly biased due to yea-sayers, that bias is not a substantial one.

The willingness to pay and work of households with municipal services indicate that there is a latent demand for improvements in system reliability and water quality. WTP estimates can be used in the design of public investment criteria, and to inform pricing, affordability and equity policies to help achieve cost recovery. In addition, estimates of willingness to work reveal the potential to implement a voluntary work program to pay for improved water services. Such a program could provide an alternative to households with excess of labor supply that deem system improvements to be necessary but cannot afford increases in their water bills. If the program is implemented, the municipality would observe a reduction in their costs from having a voluntary labor force to operate and maintain the water system. As *Abramson et al*. [2011] argue, cost recovery through willingness to work seems to be a promising alternative for setting sustainable water projects in poor areas such as our study site. On the other hand, the unwillingness to pay or work that was found among households with community-managed services represents a potential obstacle for CBWOs that plan to improve water services. Official assistance to invest in water systems would be required to improve the quality of water services in rural areas [*Vásquez*, 2014]. CBWOs would also benefit from the institutional support of government agencies such as INFOM and MSPAS to improve their operational and managerial skills, in order to increase community participation and system revenues. This issue deserves more attention in future studies.

References

Abramson, A., N. Becker, Y. Garb, and N. Lazarovitch (2011), Willingness to pay, borrow, and work for rural water service improvements in developing countries. *Water Resour. Res.*, *47*, W11512, doi:10.1029/2010WR010147.

Ahlheim, M., and F. Schneider (2013), Considering household size in contingent valuation studies, *Environ. Econ.*, *4*(1), 112–123.

Ahlheim, M., O. Fror, A. Heinke, N. M. Duc, and P. Van Dinh (2010), Labour as a utility measure in contingent valuation studies: How good is it really?, *FZID Discuss. Pap. 13–2010*, Univ. Hohenheim, Stuttgart.

Arouna, A., and S. Dabbert (2012), Estimating rural households' willingness to pay for water supply improvements: A Benin case study using a semi-nonparametric bivariate probit approach, *Water Int.*, *37*(3), 293–304.

Ballestero, M., E. Brown, A. Jouravlev, U. Küffner, and E. Zegarra (2005), Administración del Agua en América Latina: Situación Actual y Perspectivas, *Ser. Recursos Naturales e Infraestructura 90*, Comisión Económica para América Latina y el Caribe (CEPAL), Santiago de Chile, Chile.

Carson, R.T. (2012), Contingent valuation: A practical alternative when prices aren't available, *J. Econ. Perspect.*, *26*(4), 27–42.

Carson, R. T., N. E. Flores, and N. F. Meade (2001), Contingent valuation: Controversies and evidence, *Environ. Resour. Econ.*, *19*, 173–210.

Casiwan-Launio, C., T. Shinbo, and Y. Morooka (2011), Island villagers' willingness to work or pay for sustainability of a marine fishery reserve: Case of San Miguel island, Philippines, *Coastal Manage.*, *39*, 459–477.

Champ, P. A., K. J. Boyle, and T. C. Brown (2003), *A Primer on Nonmarket Valuation*, Kluwer Acad, Norwell, Mass.

Christie, M., and C. D. Azevedo (2009), Testing the consistency between standard contingent valuation, repeated contingent valuation and choice experiments, *J. Agric. Econ.*, *60*(1), 154–170.

D'Andrea, A. (2012), Legal pluralism and customary water resources management in Guatemala, *Water Int.*, *37*(6), 683–699.

Eom, Y., and D. Larson (2006), Valuing housework time from willingness to spend time and money for environmental quality improvements, *Rev. Econ. Househ.*, *4*(3), 205–227.

Fundación Centroamericana De Desarrollo (FUNCEDE) (2011), Comportamiento Electoral Municipal En Guatemala: Elecciones General 2007, *Ser. de Estudios 22*, Guatemala.

Galindo, H., and J. Molina (2007), *Valoración Estratégica sobre la Importancia del Agua Potable y el Saneamiento Básico para el Desarrollo, la Salud y la Educación en Guatemala*, Red de Agua Potable y Saneamiento de Guatemala (RASGUA), Guatemala.

Greene, W. H. (2012), *Econometric Analysis*, 7th ed., Prentice Hall, Upper Saddle River, N. J.

Griffin, R. C., and J. W. Mjelde (2000), Valuing water supply reliability, *Am. J. Agric. Econ.*, *82*, 414–426.

Gunatilake, H., and M. Tachiiri (2012), Willingness to pay and inclusive tariff designs for improved water supply services in Khulna, Bangladesh, ADB *South Asia Working Pap. Ser. 9*, Asian Dev. Bank, Manila, Philipp.

Hanley, N., S. Mourato, and R. E. Wright (2010), Choice modelling approaches: A superior alternative for environmental valuation, *J. Econ. Surv.*, *15*(3), 435–462.

Hole, A. R. (2007), A comparison of approaches to estimating confidence intervals for willingness to pay measures, *Health Econ.*, *16*(8), 827–840.

Instituto de Agricultura, Recursos Naturales y Ambiente (2005), *Situación del Recurso Hídrico en Guatemala*, Documento Técnico del Perfil Ambiental de Guatemala, Univ. Rafael Landívar, Guatemala.

Instituto Nacional de Estadística (INE) (2002), *Censos Nacionales XI de Población y VI de Habitación 2002*, Guatemala.

Instituto Nacional de Estadística (INE) (2006), *Encuesta Nacional de Condiciones de Vida: ENCOVI 2006: Diseño de la Muestra*, Guatemala.

Kaiser, H. F., and J. Rice (1974), Little jiffy, Mark Iv, *Educ. Psychol. Meas.*, *34*(1), 111–117.

Kobel, D., and R. Del Mistro (2012), Evaluation of non-user benefits towards improvement of water and sanitation services in informal settlements, *Urban Water J.*, *9*(5), 347–359.

Lankia, T., M. Neuvonen, E. Pouta, and T. Sievänen (2014), Willingness to contribute to the management of recreational quality on private lands in Finland, *J. Forest Econ.*, *20*(2), 141–160.

Loomis, J., and L. Santiago (2013), Economic valuation of beach quality improvements: Comparing incremental attribute values estimated from two stated preference valuation methods, *Coastal Manage.*, *41*, 75–86.

Organization for Economic Co-operation and Development (OECD) (2003), *Social Issues in the Provision and Pricing of Water Services*, Paris, France.

Pattanayak S. K., J. C. Yang, D. Whittington, and K. C. Bal Kumar (2005), Coping with unreliable public water supplies: Averting expenditures by households in Kathmandu, Nepal, *Water Resour. Res.*, *41*, W02012, doi:10.1029/2003WR002443.

Perez-Pineda, F., and C. Quintanilla-Armijo (2013), Estimating willingness-to-pay and financial feasibility in small water projects in El Salvador, *J. Business Res.*, *66*(10), 1750–1758.

Rai, R. K., and H. Scarborough (2012), Economic value of mitigation of plant invaders in a subsistence economy: Incorporating labour as a mode of payment, *Environ. Dev. Econ.*, *18*, 225–244.

Rangel, J. M., B. Lopez, M. A. Mejia, C. Mendoza, and S. Luby (2003), A novel technology to improve drinking water quality: A microbiological evaluation of in-home flocculation and chlorination in rural Guatemala, *J. Water Health*, *1*(1), 15–22.

Secretaría de Planificación y Programación de la Presidencia and Instituto Nacional de Estadística (2006), *Mapas de Pobreza en Guatemala 2002*, Guatemala.

Van Hecken, G., J. Bastiaensen, and W. F. Vásquez (2012), The viability of local payments for watershed services: Empirical evidence from Matiguás, Nicaragua, *Ecol. Econ.*, *74*, 169–176.

Vásquez, W. F. (2011), Municipal water services in Guatemala: Exploring official perceptions, *Water Policy*, *13*(3), 362–374.

Vásquez, W. F. (2012), Reliability perceptions and water storage expenditures: Evidence from Nicaragua, *Water Resour. Res.*, *48*, W10547, doi:10.1029/2011WR011024.

Vásquez, W. F. (2013a), An economic valuation of water services under different approaches of service governance, *Water Resour. Econ.*, *2–3*, 17–29.

Vásquez, W. F. (2013b), A hedonic valuation of residential water services, *Appl. Econ. Perspect. Policy*, *35*(4), 661–678.

Vásquez, W. F. (2013c), Rural water services in Guatemala: A survey of institutions and community preferences, *Water Policy*, *15*(2), 258–268.

Vásquez, W. F. (2014), La Gestión de los Servicios Comunitarios de Agua Potable en Guatemala, in *Guatemala: Gobierno, Gobernabilidad, Poder Local y Recursos Naturales*, edited by G. Sánchez Medero and R. Sánchez Medero, in press.

Vásquez, W. F. and D. Franceschi (2013), System reliability and water service decentralization: Investigating household preferences in Nicaragua, *Water Resour. Manage.*, *27*(14), 4913–4926.

Vásquez, W. F., and J. Trudeau (2011), External and internal consistency of user evaluations, *Int. J. Public Admin*, *34*(14), 918–925.

Vásquez, W. F., P. Mozumder, J. Hernández, and R. Berrens (2009), Willingness to pay for safe drinking water: Evidence from Parral, Mexico, *J. Environ. Manage.*, *90*(11), 3391–3400.

Wright, J., S. Gundry, and R. Conroy (2004), Household drinking water in developing countries: A systematic review of microbiological contamination between source and point-of-use, *Eur. J. Trop. Med. Int. Health*, *9*(1), 106–117.