Water Resour Manage (2012) 26:3689–3704
DOI 10.1007/s11269-012-0097-y

# Local Markets for Payments for Environmental Services: Can Small Rural Communities Self-Finance Watershed Protection?

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Received: 22 November 2010 / Accepted: 21 June 2012 /
Published online: 4 July 2012


**Abstract** Payment for environmental service (PES) programs are innovative approaches for watershed and natural resources management that increasingly are being used around the world. Most well-studied PES examples rely predominately, if not entirely, on large governmental and outside non-governmental organizations for financial and management assistance. We examine the potential for using a locally-financed PES scheme in a small, agricultural community in a developing country as a means to preserve environmental services of watersheds, namely clean drinking water. A dichotomous choice, contingent valuation survey is used to examine the community's demand for protection of the headwaters of the nearby river, the source of their drinking water. The survey results demonstrate local water users' substantial willingness to pay for increased protection of the watershed environmental services. We find that a local-market PES scheme for watershed services, even in a relatively low-income context, may be sufficient to protect ecosystem services independent of external financial resources.

**Keywords** PES · Nonmarket valuation · Ecosystem services · Water user group · Gravity-fed drinking water system

## 1 Introduction

Despite the growth of payment for environmental service (PES) programs, to date there are few empirical studies of locally-financed PES programs (Van Hecken et al. 2012). We empirically examine the potential of using a PES scheme to preserve watershed ecosystem services, including potable drinking water, in a "local market" in a developing country.

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Using a dichotomous choice, contingent valuation (CV) survey, we measure a small Costa Rican community's willingness to pay for the protection of the forested, headwater area of the Dos Novillos River. These headwaters provide the community with their potable water. Subsequently, we use estimates of local demand for the watershed services to evaluate whether local demand coupled with the extant institutional framework appear sufficient to operate a locally-financed PES program without external financial resources.

Donor agencies, non-governmental organizations (NGO), and large governmental bodies have been exploring the potential of direct payment approaches such as PES for protecting and conserving watershed and ecosystem services (Ferraro and Kiss 2002). Typically, PES programs have been state-run projects focused on providing particular public good-type ecosystem services (e.g., carbon sequestration, biodiversity protection, watershed protection) and have relied on donors and NGOs for both financing and help bridging the interests of landowners and resource beneficiaries (FAO 2004; Wunder 2005). The potential for and application of PES schemes regarding water resources, watersheds, and related ecosystem services has received increasing attention (Calvo 1990; Chomitz et al. 1998; FONAFIFO 2000; Herrador and Dimas 2000; Kerr 2002; Pagiola 2002; Sanchez-Azofeifa et al. 2002; FAO 2004; Grieg-Gran, Porras, and Wunder 2005; Pagiola et al. 2005a, b; Postel and Thompson 2005; Salzman 2005; Wunder 2005; Zbinden and Lee 2005; FAO 2007; and Porras et al. 2008).

Much of the PES literature focuses on general observations, nationwide schemes, and a few oft cited cases (e.g., the New York City (NYC)-Catskills Agreement and Costa Rica's Pagos por Servcios Ambientales (PSA)). The NYC-Catskill case illustrates, among other things, that successful PES schemes may be watershed-based, may not require international or national programming, and that they can result in significant cost savings for downstream beneficiaries (Postel and Thompson 2005; Chichilinsky and Heal 1998). Costa Rica's national PES scheme as well as Mexico's PES program (Kosoy 2008) illustrate developing countries implementing nationwide PES programs. Deforestation threatens Costa Rica's watershed services (Broadbent et al. 2012; Chomitz et al. 1998; FONAFIFO 2000; World Bank 2000; Kaimowitz 2000, 2004). As part of its response, Costa Rica pioneered an approach of direct payments to land users for land use decisions protecting the provision of environmental services (Chomitz et al. 1998; Salzman 2005; FAO 2004; World Bank 2000; Pagiola et al. 2002). However, only a small portion of land in Costa Rica that is actually eligible under the PSA participates in the national program (Pagiola 2002; Pagiola et al. 2005b).

## 1.1 Water Services Research

Economic valuation studies of consumer preferences and willingness to pay for drinking water and sewer service sectors have been successfully carried out in industrialized nations (e.g., MacDonald et al. 2010) as well as in developing and newly industrialized nations such as Egypt (Hoehn and Krieger 2000; Hoehn et al. 1999) and Haiti (Whittington et al. 1990). Contingent valuation surveys have been used to quantify downstream agricultural producers' and urban residents' WTP for a rural water system in Eastern Montana (Piper 1998) as well as for cost-benefit analyses of maintaining water quality in western and central North Carolina (Eisen-Hecht and Kramer 2002). In developing country contexts, CV surveys have been used to estimate household demand for improved piped water service in Nepal (Whittington et al. 2002) and Brazil (Briscoe et al. 1990) as well as to estimate the value of waste water services in Burkina Faso (Altaf and Hughes 1994) and the Philippines (Choe et al. 1996).

As Briscoe et al. (1990) observed, the benefits of improved water supplies are so great that people in developing countries can and will pay for improved water services. In fact, the tariffs for yard taps in rural Brazil can be increased substantially before significant numbers of households would choose not to connect to an improved water system (Briscoe et al. 1990). Subsequent analysis by the World Bank Water Demand Research Team of rural demand for water in developing countries highlights how socio-economic characteristics of households, characteristics of the existing and improved water supply, and household attitudes towards government policy jointly influence households' willingness to pay for an improved water supply (World Bank 1993). An examination of households' WTP for improved piped water services in Kathmandu, Nepal showed that poor and non-poor households are willing to pay much higher water fees than their current water bills for improved water services (Whittington et al. 2002). A CV study of respondents' willingness to pay for improved operation of a wastewater treatment plant, improved water quality, and improved environmental quality in a Greek community found respondents' willingness to pay (€ 15.23 due every 4 months) the rough equivalent of cost of operating the wastewater treatment plant (Kontogianni et al. 2003).

Increasingly, there is recognition that resource regimes involving local water-user groups in governance and management are more likely to result in better management of natural resources, especially water resources (Douglas et al. 2007). For example, community-based management committees have been found to play a vital role in the sustainability of rural water schemes, especially those involving groundwater user associations (Lopez-Gunn and Cortina 2006). A strong institutional framework is essential for successful alternatives (e.g., community organizations, water user associations) to public delivery of water and sanitation (Phumpiu and Gustafsson 2009).

## 1.2 Watershed Ecosystems and PES Research

Healthy watersheds provide valuable ecosystem services, including a supply of potable water. Too often these ecosystem services are undervalued and underprotected because local water prices do not include the cost of maintaining or managing these valuable hydrological services. CV surveys can be a useful tool for valuing complex ecological services in rural, developing country settings (Pattanayak and Kramer 2001). Partnerships between landowners providing watershed services and those benefiting from the services may be prove to be especially important in watersheds in developing countries (Postel and Thompson 2005).

Most PES programs have operated as monopsonies, with only one larger buyer (e.g., governmental agency) and multiple ecosystem service providers. There is potential for PES programs to operate on different scales, including local markets, in those instances where there are: 1) discrete consumers and providers of services; 2) clear biophysical understanding of service provision and delivery pathways; and 3) determination of the service levels required (Salzman 2005). That is, local PES schemes for watershed services should: (1) identify and quantify demand for the service, (2) ensure a functional local institutional framework, and (3) operate independently of external financial resources after start-up (FAO 2004). Understanding the conditions for successful PES programs in local markets remains unclear. It is not always true that downstream service beneficiaries are wealthier than upstream service providers. When downstream service beneficiaries are poorer than upstream service providers, there may be low potential for downstream service buyers to be able to pay enough to potential upstream service providers to change their behavior (Pagiola et al. 2005b).

Rural stakeholders in Bolivia, South America participated in a CV study and revealed an annual WTP for increased drinking and irrigation water equal to 77 % of the annual cost of the proposed restoration programs (Shultz and Soliz 2007). A CV study in the North China Plain found that only 28 % of households there were willing to pay some amount of money to preserve groundwater, with those amounts being insignificant as compared to the cost of protecting and restoring the groundwater (Wei et al. 2007). It appears that water resources can only be governed appropriately if there is capacity to understand and monitor changes in water resources within a basin and if the asymmetry of the water resource problems on upstream and downstream users is addressed (Van der Zaag 2007).

A CV study estimating respondents' WTP as a percent over their current water bill for future projects to improve water supply in Rethymo, Crete found the citizens' WTP for improved service (continuous water supply) to be about 17 % more than their current water bill (Genius et al. 2008). A PES scheme in Bolivia in which external donors and governmental offices have funded forest protection reported that building trust between service buyers and providers to be one of the greatest challenges in such PES programs (Asquith et al. 2008). PES programs are not a "silver bullet" for addressing all environmental problems, but PES can be a tool for addressing systems in which ecosystems are mismanaged because many of their benefits are externalities from the perspective of ecosystem managers (Engel et al. 2008).

Another local PES study used a CV study to examine two small communities' WTP for improved watershed protection and ecosystem services in Costa Rica's Lower Reventazón watershed found significant WTP in the range of twice current monthly water charges (Ortega-Pacheco 2009). This result appears to differ from findings of Johnson and Baltodano (2004) on developing country rural households' WTP for locally-financed watershed protection. In Parral, Mexico, households currently engage in a variety of averting and private investment choices (e.g., bottled water consumption) to compensate for the existing water supply system. A CV survey revealed that these households are willing to pay from 1.8 % to 7.55 % of their reported household income, in addition to their current water bill, for safe and reliable drinking water services (Vasquez et al. 2009). A stated choice, nonmarket valuation technique, was successful for estimating implicit prices for changes in the attributes of household water services in Adelaide, South Australia (MacDonald et al. 2010).

Raising adequate payments from local beneficiaries for ecosystem services in cloud forests in Mexico may be a good option to prevent deforestation if the levels of compensation at least equal to the opportunity cost of the protected lands (Martınez et al. 2009). An examination of Mexico's federal payment for environmental services programs using a political ecology framework revealed that design of PES projects entail political choices about who benefits, who has access to natural resources and their services, and how different understandings of sustainable development play out (McAfee and Shapiro 2010).

PES systems represent important ways to effectively manage ecosystem services and represent a significant departure from conventional market institutions (Farley and Costanza 2010). However, PES as a market-based strategy and its application in Costa Rica have been suggested to deviate from free-market models and appear strongly grounded in conventional command-and-control state regulation in part because of the national PES is not self-sustaining financially (Fletcher and Breitling 2012). Most recently, a study of local PES in Nicaragua found significant WTP for improved drinking water services, an awareness of upstream–downstream interdependencies, and significant barriers to PES because of extant institutional contexts (Van Hecken et al. 2012).

In this paper, we examine local stakeholders' willingness to pay for rural watershed services through the protection of the upstream forest ecosystem and source waters of the communities' principle river in a developing country with a national PES program. Thus, we contribute to the literature on the potential for locally-financed PES in a rural community located within a county with a tradition and an institutional framework that supports PES (Kaplowitz et al. 2008).

## 1.3 Research Setting

The Dos Novillos watershed is 4,800 Ha and is located from 30 to 2,530 m above sea level in eastern Costa Rica. The Dos Novillos River runs for about 29 Km before joining the Parismina River (See Fig. 1) and eventually drains into the Caribbean Sea. The Dos Novillos watershed drains areas of small-scale farms, commercial plantations, rural residences, rural towns, and commercial facilities. There are two principle communities in the Dos Novillos watershed—La Argentina and Pocora. La Argentina is in the upper section of the watershed and is primarily small farm households. Pocora, comprised of Pocora and Pocora Norte (north), is located in the lower sections of the Dos Novillos watershed and is primarily semi-urbanized households and associated commercial properties.

It is estimated that from 1992 to 1998 the forest cover in the watershed was reduced by 45 % (Arreaga and Bracamontes 2001). Deforestation is a threat to the ability of the headwater region of the Dos Novillos to provide high quality and quantity of potable water resources to La Agentina and Pocora (See Table 1). Also threatening the Dos Novillos headwaters are human waste water and livestock waste that flow into the watershed from agricultural and urbanizing areas (Cuesta 1999; Roggiero and Saucedo 2001).

The principle municipal drinking water systems in the Dos Novillos watershed are the La Argentina aqueduct and the AyA aqueduct. Aqueduct is an English translation for what most readers know as small, gravity-fed piped distribution systems. These aqueducts are supplied

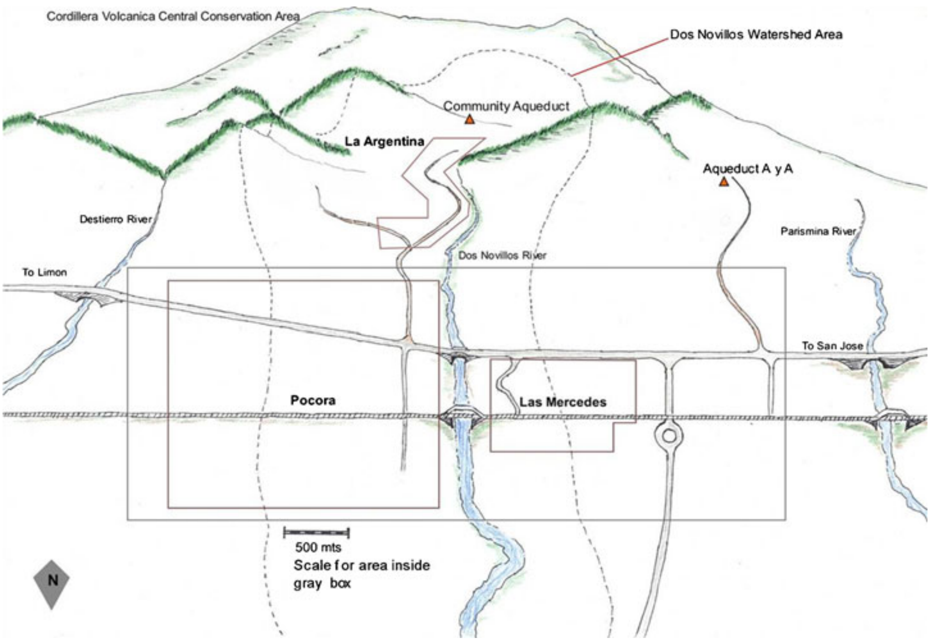


**Fig. 1** The Dos Novillos watershed in Eastern Costa Rica (facing south)

**Table 1** Households receiving water service in the Dos Novillos watershed

| Water service provider | Mean household size | Households receiving water service | No. Persons |
|---|---|---|---|
| La Argentina Aqueduct | 4.28 | 1,600 | 6,848 |
| A y A in Pocora | 4.28 | 700 | 2,996 |
| A y A in Mercedes | 4.28 | 100 | 428 |
| Total | | 2,400 | 10,272 |

(Source: Araya 2006)

with water from the headwaters (source water springs) of the Dos Novillos and use gravity to distribute water using the community owned and operated system. While the Dos Novillos River flows continuously, the river itself does not represent a ready source of potable water. To be potable, the water of the Dos Novillos River would need extensive treatment to address surface water pollutants such as pesticides, fertilizers, and sediment from the land uses of nearby plantations, farms, and commercial enterprises (Cuesta 1999).

La Argentina village's Rural Communal Committee (RCC) took the unusual step to independently build and self-finance its own drinking water system. La Argentina, unlike other communities, did not use federal, state, or other 'outside' funding to finance, build, maintain, or operate their gravity-fed water distribution system (aqueduct). The RCC identified a water source near the headwaters of the Dos Novillos and organized the effort of 470 persons over 10 years to build a 12.5 km gravity-fed piped water distribution system. This collective experience of financing, building, and maintaining their current drinking water system makes the idea of further measures to protect the headwaters of the Dos Novillos more than plausible. Interestingly, the national water agency contemplated taking over responsibility for managing and operating the La Argentina system but declined to do so when it was asked to reimburse the community for its capital investment in the water distribution system.

The number of users of the Dos Novillos water distribution system has been steadily growing; in 2001 there were 878 reported users (Arreaga and Bracamontes 2001), and in 2006 this system provided water to 1,600 households in La Argentina and two Pocora neighborhoods. The Argentina water system users pay an initial set-up charge and a fixed monthly fee of about $2 USD per household per month. The infrastructure, equipment and maintenance are very basic; there is no technical equipment involved in the provision of the service. The members of the water system (aqueduct) administration board are all volunteers elected by a general assembly. In contrast, the nearby communities receive their potable water from different municipal gravity-fed distribution (aqueduct) systems that draw water from government-owned water sources and are administered by a governmental agency (AyA).

## 2 Method

While CV surveys have become widely used both in developed and developing countries, leading experts caution that CV and other stated preference studies must be well designed and implemented to insure high quality results (See e.g., Carson 2000; Carson and Hanemann 2005; Whittington 1998, and Whittington 2002). Water services in developing countries are generally well-known commodities especially in rural communities and that researchers can provide information to respondents so that the nature of the water service to be valued is clear (Briscoe et al. 1990). For example, Griffin et al. (1995) provides clear evidence that careful CV studies can provide reliable information on people's value for well-defined goods and services such as a household's water supply.

## 2.1 Survey Questionnaire

The survey instrument was developed, in line with Carson and Hanemann's (2005) observations about good CV surveys and contains (a) sections that set the general context for the decision to be made, (b) a description of the service to be provided, (c) the institutional setting for providing the service, (d) the manner in which the service will be paid for, (e) a method for eliciting respondents preferences, (f) follow-up questions, and (g) questions about respondents' attitudes and demographic information. We used focus groups and individual interviews (Kaplowitz et al. 2004) to determine the plausibility and understandability of the scenario being presented, conducted presets to assess how well the instrument (and the survey enumerators) worked, required special training sessions for survey enumerators, and provided close field supervision of survey enumerators (Whittington 1998 and 2002; Carson 2000; Kaplowitz et al. 2004; Hoehn et al. 2003; and Kellon 2006).

The final questionnaire had five (5) sections. The first section contained questions and information about natural resource management in the watershed. The survey's second section focused on the respondents' drinking water source and service asking respondents about their tap water, who administers their drinking water service, the quality of their current drinking water and water service, as well as questions about how much they pay each month for their drinking water service. The third section of the survey asked about waste management in the area in support of another research issue. These sections were designed to convey information about the resources, their quality and connections to land uses, and possible threats to their quality. These sections also served to remind respondents about substitute goods and services.

The survey's fourth section elicited respondents' willingness to pay for the watershed protection program – contracting with local landowners to protect headwater area from deforestation. The survey's CV scenario and provision mechanism in based on the community's water association contracting with local landowners. The payment vehicle, an additional fee added to the regular monthly water bills, was actually suggested by participants in an early focus group. The CV decision rule of needing a majority to agree to pay an additional fee was also well understood and accepted by participants in the focus groups, individual interviews, and pretests. The survey's final section collected respondents' demographic characteristics.

## 2.2 Sample, Implementation, and Response

The target population for this study were adult heads of household (18 years of age or older) in the Dos Novillos watershed with drinking water service provided by a local water user group. Aerial photos were used to divide the study site into sectors with interviewers assigned to specific sectors. The sampling plan was to attempt to collect a completed survey from a head of household in "every other" home in each assigned sector. Households that were "unavailable" to complete a questionnaire were visited up to two more times in an attempt to include them in the study. Only after a sector was completely canvassed (and unavailable households revisited) was the next sector randomly assigned to an enumerator. Enumerators were recruited from Costa Rica's National University (UNA) and from EARTH University in Guácimo and trained for the task.

During implementation of the in-person survey, each interviewer kept a detailed, daily record of all attempted household contacts (e.g., eligible-interview; unknown eligibility-no interview, etc.). These records were verified by research assistants in the field and subsequently coded utilizing the American Association for Public Opinion Research (AAPOR) standards in determining response rates and cooperation rates for in-person household surveys (AAPOR 2008).

In all, 709 interviews were attempted and 398 completed survey questionnaires were collected. In this study, not every household was eligible to participate (e.g., the head of household was under 18 years old) and many homes were vacant and of unknown status. The AAPOR Response Rate 1 (RR1) or "minimum response rate" includes all attempts in the denominator and was 60.1 %. Another measure of participation for in-person surveys is the cooperation rate. The AAPOR cooperation rate (CR1) is estimated as the proportion of all interviews by eligible households relative to the total number of household contacts made (AAPOR 2008). There was a high degree of cooperation by households in the watershed with more than 89.4 % of heads of households contacted by interviewers completing the survey.

## 2.3 Probit CV Model

The survey was designed as a dichotomous choice referendum, a standard approach for eliciting respondent's willingness to pay (Haab and McConnell 2002). In the dichotomous choice framework, each respondent is asked whether he/she would be willing to pay a specified amount for a specified good/service/program. A respondent answers with "yes" or "no" to the "bid" amount offered (Haab and McConnell 2002). We follow the convention of treating the yes/no answers as observations from an underlying continuous distribution on WTP (Cameron and Quiggin 1994). If a respondent answers "yes" to a cost (bid amount), then the respondent's true WTP is assumed to be greater than the cost. We measure this with error, so we have the standard statistical model of $WTP_j = \beta_j z_j + \varepsilon_{ij}$ where the latter term, $\beta_j z_j$, represents the parameterization of the mean, μ for person *j*'s demographic variables, $z_j$. We assume that person *j* will answer "yes" for the program if $WTP_j \geq c_j$, where $c_j$ denotes the program cost to respondent j. What we can observe is the relationship of $WTP_j$ for person *j* to the bid amount shown to *j*, $c_j$.

To implement a model, we assume that the errors have a normal distribution which yields a probit model (Haab and McConnell 2002), so that:

Probability of a "yes" answer is

$$\Pr(y = 1) = \Pr\left(\beta_j z_j + \varepsilon_{ij} > c_{ij}\right) = \Phi\left[\left(\beta_j z_j - c_{ij}\right)/\sigma\right] \tag{1}$$

where $\beta_j z_j$ represents the mean value for person *j*'s willingness to pay given *j*'s covariates $z_j$; y is an indicator that equals 1 for yes answers, 0 for no answers.

## 2.4 Bid Design

To use our probit model, we needed to insure that there was appropriate variation in the bid amounts (costs) shown to respondents. Four "initial" bid amounts were used in our bid design (see the first column of Table 2). The bid amounts were set based on what we learned during the qualitative research phase of the project (i.e., focus groups and individual interviews). Each survey participant was randomly assigned one of the four "initial" bids. To protect against potential errors in the spread and size of the bid amounts, we analyzed

**Table 2** Bid sets before and after updating (colones)

| | Bid Set A | | Bid Set B | |
|---|---|---|---|---|
| | Bid | N | Bid | N |
| 1 | ¢ 200 | 48 | ¢ 400 | 39 |
| 2 | ¢ 400 | 54 | ¢ 800 | 47 |
| 3 | ¢ 800 | 50 | ¢ 1600 | 46 |
| 4 | ¢ 1200 | 21 | ¢ 2400 | 77 |
| Total | | 173 | | 209 |

[a]The percentage of yes responses at the various bid amounts is given as follows: 77.1 % at 200, 74.2 % at 400, 71.4 % at 800, 70.1 % at 1200, 65.2 % at 1600, and 46.8 % at 2400 colones

preliminary results and subsequently updated the bid amounts during the survey implementation (Rollins et al. 1997). After the first 183 respondents, a preliminary model was estimated. The model performed well, but the responses to the valuation question contained a high proportion of yes responses. Consequently, we increased (doubled) the bids to improve our ability to capture the upper tail of the WTP distribution. The responses were analyzed again after about 300 responses, but no further adjustment was made since the percentage of no votes at the upper tail had increased as desired. The two sets of bids are presented in Table 2.

## 3 Results

### 3.1 Parameter Estimates

The variables included in the probit model were a constant, monthly program cost, and variables for respondents' age, education and monthly income along with measures of their satisfaction with their current water service, their concerns about water quality, and their perceptions of future threats to water quality. The parameter on the cost term recovers the inverse of the estimated variance. The age variable is computed as the natural logarithm of the respondent's age, the education variable is a dummy variable taking the value one if the respondent completed high school, and the monthly income variable is derived from the stated monthly earnings of each household member. The measure of satisfaction of the current drinking water service was obtained using a five-point scale, from extremely good to extremely poor. The quality concern variable measures respondents' concern with the current quality of their water and the threat to future water quality variable captures respondents' perceived significance of agrochemical contamination of their water supply. Both these variable are based on a rating using a five-point scale.

The estimated model uses data from 377of the 398 respondents that provided valid responses for the survey's valuation question and who also provided sufficient demographic information for estimation (See Table 3). The reduction in data is due to 16 people that refused or were unable to answer the CV question (resulting in 382 valid responses to the CV question) and 5 additional cases that were dropped from the analysis because of missing demographic data. In addition, the household income variable was calculated by adding up the monthly earnings of each of the household members. This section of the questionnaire contained about 65 cases where earnings data on some or all household members was missing or unknown. In these cases the mean value was used to impute the missing items. This approach was tested and did not have an effect on mean WTP when compared to models without income. If the persons with a missing earnings figure are dropped from the

**Table 3** Probit model from CV referendum question

| Variable | Coefficient | Z-values[a] | *P*-values[a] | Variable means | Marginal effects[b] |
|---|---|---|---|---|---|
| Constant | 2.41 | 2.75 | 0.006 | | |
| Monthly cost (in -1000 colones) | 0.378 | 4.08 | <0.000 | 1.077 | 0.131*** |
| Ln (age) | −0.462 | −2.26 | 0.024 | 3.74 | −0.160** |
| Education level: High School or greater | 0.473 | 1.60 | 0.110 | 0.110 | 0.160* |
| Monthly income (in 10000 colones) | 0.0434 | 3.08 | 0.002 | 13.72 | 0.015** |
| Current water service rating | 0.121 | 1.70 | 0.088 | 2.33 | 0.042* |
| Concern about current quality | 0.476 | 2.77 | 0.006 | 0.29 | 0.15*** |
| Future agro- chemical threat | 0.107 | 2.29 | 0.0221 | 2.31 | 0.037** |
| N | 377 | | | | |
| LogL | −194.6 | | | | |
| Chi-squared | 61.44 | | | | |
| McFadden $R^2$ | 0.14 | | | | |
| % Predicted Correctly | 71.8 % | | | | |

[a] Z-stats and P-values are based on robust standard errors computed using the sandwich estimator

[b] Marginal effect of variable on the probability of voting yes evaluated at the mean values of the independent variables with variances computed using the delta method; ***,**,* represents significance at the 1 %,5 % and 10 % level

analysis instead of imputing the missing earnings data, the mean WTP increases 15 % to 20 % depending on the model specification.

As expected, increased monthly program cost significantly reduces the probability of answering yes and supporting the program (recall from Eq. 1 that cost enters the model with a negative sign so that a positive parameter means that the effect of higher costs is negative). As the cost of the ecosystem protection program increased, the likelihood of a ‘no’ answer for the program increased. The results show that older people are less likely to answer ‘yes’ ($p$=0.024), but this effect declines with age. The model estimates show that persons with a higher level of education (high school degree or beyond) are more likely to say yes to the program ($p$=0.113) with a marginal effect on answering yes that was significant at the 10 % level ($p$=0.064). Also, higher monthly income significantly increases the likelihood of answering yes to supporting the watershed protection program ($p$=0.002). Regarding the current drinking water service, it appears that the better a respondent rated their quality of service the higher their probability of answering yes to supporting the protection program ($p$=0.088). This result is consistent with our expectation that respondents that feel they are getting good drinking water service have more to protect than respondents that feel they are getting poor service. Respondents who indicated that they are concerned with water quality were significantly more willing to answer yes for the watershed protection program ($p$=0.006). Here too, this result is consistent with our expectation that those with concerns over quality would perceive that there is more to protect through the PES program than respondents that do not have such concerns. The final variable in the model represents respondents’ perception of the future threat that agrochemical contamination poses to local water quality, and the results show that those who perceived a greater threat in the future had a larger probability of answering yes to support the PES program ($p$=0.022).

Other demographic variables that have been found to be useful explanatory variables in other studies such as current water source/distribution system (recall there are two different aqueducts in the region), number of children in the household, homeownership, gender of the interviewed head of household, and marital status were examined in a post hoc, stepwise approach. However, none of these variables had a significant effect on the stated preferences at any conventional levels of significance. Consequently, the results in Table 3 represent only those variables with parameters or marginal effects that were significant at the 10 % level. Insignificant variables are excluded so that they are not used in forecasting the WTP amounts. Interestingly, respondents' concerns about water quantity did not have a significant effect on the probability of them supporting the PES program. However, since water quantity is not an issue and the primary focus of the proposed program is water quality protection, the lack of significance of concerns over quantity were not surprising.

Table 3 also presents several measures of model fit. The Chi-squared statistic for the joint significance of the seven model variables (other than the constant) allows us to reject the null hypothesis that the model parameters are zero ($p<0.000$). The model correctly predicts 72 % of the actual answers using the conventional probability cut-off of 0.5 to classify predictions.

## 3.2 Willingness to Pay

To calculate the mean willingness to pay (WTP) for watershed ecosystem protection, we follow Cameron's (1987) approach (see also Haab and McConnell 2002) which uses the estimated parameter values from our probit model to recover the underlying mean WTP as follows: $\widetilde{\alpha}/\widetilde{\delta} + \widetilde{\beta}j/\widetilde{\delta}Zj$ , where $\widetilde{\delta} = 1/\sigma$ is the parameter on the cost variable and the ~'s represent the estimated values from Table 3. The estimated mean WTP for the study sample is 2,479 colones ($4.66) per month per person (exchange rate $1=¢500). As explained to respondents, this fee would be in addition to their current monthly fee for water service that averages ¢983 ($1.97) per household in the survey data. The mean WTP is significantly different from zero. Using the Krinsky-Robb procedure with 10,000 draws, the 95 % confidence interval on WTP was (¢1939, ¢3848), and the 99 % confidence interval was (¢1853, ¢4432). The mean WTP is also robust to a wide range of model specifications regarding the various demographic variables gathered in the survey. For example, the mean WTP from a model without any demographic variables (i.e., $z_j=1$) is ¢2,336 ($4.67) per month per person. The estimated mean monthly WTP is about 1.7 % of the average monthly income for the respondents. Given the symmetry of the underlying distribution, the median WTP is also the mean WTP. As such, the results imply that at an additional fee of about ¢2,400 per month to protect water quality through a PES program, half of the households would be better off with the program. At watershed protection fees below this level, an even larger share of households would benefit.

As further context, the estimated mean WTP amount compares favorably to the water bills in areas surrounding the study site. In Guápiles, a larger town 23 km from La Argentina, households have water meters and they pay the national water agency for every cubic meter of water consumed. In Guápiles, the average monthly water bill was reported to be of ¢6,072 ($12.14). In the town of Aserri, a suburban area 70 km from La Argentina near Costa Rica's capital city, water is provided by a gravity-fed water distribution system (comparable in size to the one in La Argentina). The monthly water bills there is fixed at a rate of ¢3,800 ($7.60) per month. In Heredia. in Costa Rica's Central Valley, basic water service costs households around ¢6,000 ($12.00) per month and each house has a meter so that once the user goes beyond the 23 cubic meters, they pay an additional charge of about ¢300 per cubic meter. This results in households in Heredia having monthly water bills of about ¢10,000 ($20.00). Therefore, the estimated WTP for the watershed protection fee to be added to La Argentina households' current water bills appears to be reasonable.

## 4 Discussion

The estimated willingness to pay amount for watershed protection is significant and establishes that there are significant demand-side findings for establishing a locally-funded PES systems in rural watersheds. That is, the results suggest that households with modest incomes may be willing to contribute (make payments) for local ecosystem protection. However, demand for ecosystem protection at the local level may not be adequately met by the supply of ecosystem protection by current landowners. In the study area, land in the upper watershed, for the most part, is in private ownership. It remains an unanswered question whether the WTP for the protection of/maintaining the provision of ecosystem services in La Argentina is sufficient to compensate local landowners to undertake adequate protection of the Dos Novillos upper watershed. To explore the potential of PES to preserve drinking water quality in the study area, we use the mean WTP (also the median WTP) as a starting point. In the context of our CVM question and data, the WTP estimate represents the additional monthly fees that half (50 %) of the community would approve for a program to protect the quality of their drinking water services. Of course, one could estimate a (lower) percentile value if one were interested in the WTP associated with a larger likely approval level or if one wanted to be conservative with the CVM data. However, for illustration, we use this amount to examine the potential for local PES in La Argentina. Moreover, the WTP estimate associated with 50 % voting in favor is in line with local decision making rules, but we recognize that the WTP estimate may represent an upper bound on the possible revenue and amount of upper watershed lands that might be protected without making most households worse off.

We first aggregate the mean WTP as a rough estimate of the possible monthly payments that might be available to pay for watershed protection. The mean monthly WTP was 2,479 colones ($4.96) per household which scales up to an annual mean WTP per household of ¢ 29,748 ($59.50). If all 2,400 households are required to pay this increased fee, the proposed protection program could raise about ¢71,000,000 ($142,800) each year. The upper portion of the Dos Novillos watershed contains, at most, 1,000 ha of land in the catchment area for the current drinking water systems. Hydrologists believe that adopting sustainable land management practices on about 500 ha in the upper Dos Novillos watershed would ensure protection of current water supplies. Outright purchase of these 500 ha is estimated, based on prices at the time of the study, to cost between ¢1,000,000 ($2,000) to ¢2,000,000 ($4,000) per hectare. That is, the fee simple purchase price for the entire 500 ha headwater area would be one to two million colones. Obviously, one year's water protection fee could not accomplish the outright purchase of these 500 ha. The potential revenue from the watershed protection fee (the demand side analysis) appears to be sufficient to support the outright purchase of 35 to 70 ha of land in the headwater region per year.

However, the outright purchase of the land in the headwater region is not necessary or even advisable for PES. To protect hydrological services, land in the upper watershed does not need to lay fallow or undisturbed, it simply needs an incentive to be managed in sustainable ways. That is, land in the upper catchments could still be used in environmentally benign manners that allow landowners to generate some income. This income would not likely be as much income as the present forestry and agricultural practices provide. Therefore, the net cost of contracting with landowners to place land use controls and use sustainable land practices on such lands would likely be much less than the cost of outright fee simple purchase, although one must also include the monitoring and enforcement costs. As such, it is very likely that a greater area of land could be protected each year with contractual PES agreements as opposed to outright purchase each year using the income stream from the protection program fee. Thus, an estimate of protecting an additional 42−84 ha per year seems to be very conservative—enough to fully protect the headwaters in 6–12 years. Such use of alternative land management and acquisition approaches might prove to be a promising approach for using locally-financed PES. For example, conservation easements are used in the United States to successfully protect and preserve land and ecosystems and such contractual approaches might help communities elsewhere protect their valuable natural resources at costs much less than the purchase price. Our results suggest that, in this eastern Costa Rican watershed, a PES scheme that collects fees from local service beneficiaries (demand side) over the next 10 years or so would likely be sufficient to provide the local finances to protect their headwaters.

Of course, much more needs to be known about the hydrological/water quality effects of alternative land management schemes as well as landowner's willingness to contract for the provision of watershed protection in order to properly target PES program activities. However, the results of this study suggest that it is worthwhile learning about such hydrological effects for proper design and implementation of local PES watershed programs. Furthermore, the results demonstrate that even households with modest incomes recognize the value to them in protecting ecosystem services dependant on healthy watersheds. These results strongly suggest the value of exploring the viability of establishing local markets for PES schemes. Such explorations might include accurate estimations of the costs of land acquisition and protection, better understanding of the hydrologic and water quality benefits of targeting specific areas as well as specific land use practices in watersheds, as well as study of the institutional barriers and incentives to implementation of local PES schemes.

Our empirical results show that all segments of the income distribution in the study area exhibited significant positive willingness to pay for additional watershed protection. Of course, those with higher incomes were willing to pay more. The results provide an exception to the oft repeated, more general observation that there is low potential for downstream ecosystem service buyers to transfer positive payments to upstream ecosystem service providers (Pagiola et al. 2005b, 249). Another way that our case study appears to differ from other literature is that the local community of La Argentina has already borne significant costs (and benefits) of constructing and managing their own gravity-fed drinking water distribution system. In communities where current water fees may not be adequate to cover the capital and maintenance costs of 'their' drinking water systems, there may be less potential for locally-financed PES drinking water schemes since any increased fees might first go to cover the short fall in capital and maintenance costs. Further research is needed to examine the supply-side of "upstream" environmental services and to test the transferability of benefit estimates and valuation methods across communities and watersheds.

Conventional payment for environmental service (PES) programs, if there is such a thing, have already been advanced by Costa Rica as promising instruments for providing mitigation of greenhouse gases, provision of hydrological services, biodiversity conservation, and provision of scenic beauty for ecotourism. The Costa Rican public seems to have become increasingly aware of the benefits of healthy ecosystems and ecosystem services (including the tourism built around enjoying them). After its initial reliance on centrally managed and financed PES programs, Costa Rica may be ready for PES applications that do not rely largely, if not entirely, on large governmental or non-governmental agencies for financial and management assistance. This paper begins to address the call for empirical research on the demand-side of markets for PES programs (e.g., FAO 2004; Pagiola 2002; Pagiola et al. 2002; Postel and Thompson 2005), and its results reveal substantial willingness to pay on the part of local "downstream" water users to pay for upstream ecosystem services.

**Acknowledgements** The authors thank EARTH University, especially Drs. Daniel Sherrard, Carlos Hernandez and Bert Kohlmann, for valuable help. We also appreciate the assistance of members of La Argentina rural water service association, especially Don Eladio Chinchill. Thanks to Delanie Kellon for her help with fieldwork and to Stefano Pagiola for his useful insights and comments. This research was funded, in part, by the U.S. Department of State's White Water to Blue Water Initiative; the Fulbright U.S. Scholars program; Michigan State University's Vice President of Finance and Operations. All opinions, errors and omissions are the authors.

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