The economic value of basin protection to improve the quality and reliability of potable water supply: the case of Loja, Ecuador

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Abstract

The objective of this study was to estimate the economic value that people living in Loja, Ecuador, place on the protection of two basins when the protection is designed to improve both the quality and reliability of the water supply for human consumption by urban residents. Empirical results indicate that households have an average willingness to pay (WTP) of $5.80 per month to preserve the basins. The main variables affecting WTP are current monthly water cost, perception about the fairness of the existing water price, the number of hours that service is available, and the gender of the individual interviewed. The results of this study, and the later implementation by the Loja City Municipality of a basin protection project funded through a fee on water users, provide evidence that households at all income levels strongly support and are willing to pay for a project that has the potential to improve the quality of water services and protect the environment.

Keywords: Basin protection; Contingent valuation; Ecuador; Loja

1. Introduction

Like many cities located in the South American Andes, Loja, the capital of Ecuador’s Loja Province, receives most of the drinking water for its 119,000 habitants from high elevation wetland ecosystems called ‘páramos’. Water from the páramos flows down into the valley where the city is located after passing through several basins and micro-basins. Land use changes due to human and agricultural activity have cost Loja’s basins a sizable portion of their original vegetation cover and raised concerns regarding the sustainability of the basins as a dependable water supply source for the city.

In order to ensure the sustainability of Loja’s water sources, several local institutions have proposed protecting the micro-basins using funds obtained from city water users. This study estimates Loja

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household willingness to pay (WTP) to protect the micro-basins of ‘El Carmen’ and ‘San Simon’ which supply 43% of the potable water used in Loja. These two micro-basins are part of the ‘Zamora Huayco’ basin which covers an area of 3,113 hectares. Between 1976 and 1998, human activity decreased the natural forest in the area by 25%. At the same time, urban settlement within the basin increased nine-fold (Benavides & Solano, 2005).

The results of this study were intended to provide policy makers with information to help them assess the benefits and costs of plans designed to protect the two micro-basins. Thus, in addition to presenting willingness to pay results, a cost–benefit analysis of the proposed basin protection plan is also presented. Moreover, the subsequent implementation of a basin protection plan by the Loja City Municipality through a fee imposed on water users is documented. This study contributes to the economic valuation literature for basin protection because it estimates the economic value that individuals living in an urban area of a developing country place on basin protection, when the protection is designed to enhance the water supply for human consumption.

1.1. The water supply service in Loja, Ecuador

The city of Loja is located in the southern portion of Ecuador and is situated 2,100 m above sea level. Loja has a mild Andean climate, ranging between 16 and 30°C. As in other growing cities in many developing countries, the demand for water services in Loja is increasing. Between 1996 and 2006, the number of households connected to the Loja public water system more than doubled, increasing from nearly 11,000 to about 25,000 households. Nineteen percent of the households connected to the water system have access to water for less than six hours per day, and most city households (78%) consider their water supply to be insufficient. Additionally, 70% of all households rate their water quality as poor (Arias & Benavides, 2005; NCI, 2006).

Loja’s water supply and sewer system administration, UMAPAL (Unidad Municipal de Agua Potable y Alcantarillado), provides and maintains the city’s potable water and wastewater services, and in 2006 UMAPAL provided water services to 24,587 households in Loja (NCI, 2006). Potable water prices are based on the volume of water consumed in each of the five use categories: residential (84.9% of customers), commercial (11.9%), industrial (0.04%), government (0.8%) and senior citizens (2.3%). According to UMAPAL’s records, the average price paid by all consumers in Loja is $0.18/m³. Residential households, accounting for the majority of consumers, pay $0.13/m³, whilst industrial consumers pay about $0.89/m³, the highest price among all user categories.

The ‘El Carmen’ micro-basin covers an area of about 1,000 hectares and the ‘San Simon’ basin has an area of about 600 hectares. These two micro-basins have an average altitude of 2,500 m above sea level, a maximum altitude of about 3,400 m above sea level and an average annual precipitation of approximately 1,400 mm. Over time, human activities in both basins have adversely affected water quality and decreased the likelihood that potable water can be dependably supplied to Loja. For example, Benavides & Solano (2005) found a variety of coliforms in water samples taken from ‘San Simon’ creek. The coliform contamination was likely caused by households living in the micro-basins without access to the city’s sewer system and/or a result of livestock production activities in the area. Today, the ‘El Carmen’ micro-basin has a population of 82 individuals living in 14 households, and the ‘San Simon’ micro-basin has a population of 210 individuals living in 40 households. Both basins are also threatened by potential water contamination from agrochemicals used in agriculture and livestock production. The basin’s water supply has been adversely affected by logging of the natural forests in the
Zamora Huayco’ basin, which has decreased forested land from 1,630 hectares in 1976 to 1,247 in 1998 (Benavides & Solano, 2005).1

1.2. Literature review

Several studies have estimated the monetary value for a specified level of change in the water supply service in both developed and developing countries. In a Mexico City study, Montes de Oca et al. (2003) observed that households were willing to pay more than double the current price (147% increase) to both avoid water service deterioration and improve the reliability and quality of the service. Casey et al. (2005) found that six low-income communities in the eastern area of Manaus, Brazil were willing to pay between US$6.10 and US$8.70 per month to gain access to water 24 hours per day. Rodriguez (2003) estimated that households in ten communities in Cotacachi, Ecuador, were willing to pay approximately 50% more than they currently paid to improve the quality and reliability of their water supply system. In a study of rural communities in Nicaragua, Johnson & Baltodano (2004) found that households were willing to pay 0.61% of their monthly income to improve the quantity and quality of their most frequently used water sources, including the source of potable water.

We found only three studies that have estimated the direct economic relationship between basin protection and potable water service improvements. Eisen-Hecht & Kramer (2002) estimated household WTP to protect a basin to maintain the water quality of the Catawba River that runs through North and South Carolina, and which provides drinking water to several nearby municipalities. They estimated river basin residents had an annual mean WTP of $139 for a management plan designed to protect the river’s water quality. Echavarria et al. (2004) conducted a survey in 2002 in the town of Pimampiro in the Northern Province of Ibarra, Ecuador, and found that 83% of water users were willing to protect the watershed that delivers water to the town. Shultz & Soliz (2007) estimated households’ WTP for a proposed upper watershed restoration program to improve drinking water in the Santa Cruz province of Southeastern Bolivia. Mean monthly household WTP was $1.95 (65% of current charges).

2. Material and methods

This study uses contingent valuation (CV) to estimate household’s willingness to pay (WTP) to protect the ‘El Carmen’ and ‘San Simon’ micro-basins. The CV method uses surveys to ask individuals their willingness to pay for a specified level of change in an environmental resource (Mitchell & Carson, 1989). CV has been used in several countries to measure the value of household water quality improvements (Whittington, 1998; Rodriguez, 2003). Measuring household WTP for drinking water improvement using the CV method has credibility for two reasons: first, respondents are asked to impute their WTP for a well-defined and well understood good with primarily personal use benefits; second, it is possible to compare the survey results with actual behavior when the water improvement project is implemented (Goldblatt, 1999).

1 There is still an ongoing international scientific debate regarding the relation between vegetation types (i.e. pastures versus natural forests) and long-term water balance in catchment areas (Andréassian, 2004). However, there is some evidence regarding the flow-stabilization capacity of the Andean ecosystems in high altitudes (Buytaert et al., 2005).
2.1. Theoretical framework

The theoretical underpinnings of the WTP concept are based on the consumer utility maximization problem (Hanemann, 1991). The consumer problem is to maximize a utility function, \( u(\cdot) \), subject to a budget constraint. Utility is defined over the quantity of market commodities whose consumption can be denoted by a vector, \( x \), as well as another commodity whose consumption can be denoted by \( q \), which could represent the supply of a public good or amenity or a measurement of a good’s quality (e.g., water supply reliability). The solution to the problem yields a vector of ordinary demand function, \( h(p, q, y) \), and an indirect utility function \( v(p, q, y) = u(h(p, q, y), q) \), where \( p \) is a price vector corresponding to the vector \( x \) and \( y \) is income. Now, consider a change in \( q \) from \( q_0 \) to \( q_1 \) (e.g., an improvement in the reliability of the water supply). A measurement of the value a consumer places on the improvement of \( q \) can be derived by determining the magnitude of WTP, such that the following equality holds:

\[
v(p, q_1, y - \text{WTP}) = v(p, q_0, y).
\]

2.2. Survey

A person-to-person household survey of a random sample of Loja’s water service consumers was conducted in December, 2005. The survey generated 106 observations, but only 100 were usable because six households were not connected to the city’s water supply system. In addition to the CV question, the survey collected information on the demographic and socio–economic characteristics of the respondents, perceptions about the water supply services and administration, and the price paid for the service.

The contingent valuation question was asked using an open-ended elicitation format\(^2\). This elicitation technique consists of directly asking the respondent the maximum monetary value they are willing to pay for a specific change in a public good (Venkatachalam, 2004). Similar to other elicitation formats, the open-ended format has strengths and weaknesses. Loomis (1990) notes the answers to open-ended questions do not have starting point bias and have the same reliability as dichotomous choice estimates. However, open-ended questions are more difficult to answer than closed-ended ones and can induce strategic bias in respondents (Hanemann, 1994).

In a similar way to previous WTP studies on water quality issues (Eisen-Hecht & Kramer, 2002; Rodriguez, 2003; Johnson & Baltodano, 2004), the WTP question was asked after a statement describing the current situation of the micro-basins and its contribution to Loja’s water supply. This statement was designed to reduce the hypothetical bias regarding the knowledge individuals had about watershed protection and the importance of the watershed to the quality of Loja’s drinking water supply. Key points included in the statement were: (a) the uncertainty regarding the future supply of water to the city, given current population growth and the ongoing deforestation and degradation of the micro-basins that provide water to the city; (b) the presence of private owners in the micro-basins devoted

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\(^2\) Both phone and mail surveys are uncommon in Ecuador. Calls from unknown individuals asking about personal expenses and/or demographic characteristics are received with suspicion. In the case of mail surveys, all return mail within the city has to be personally deposited in the postal service office in downtown which would likely reduce the survey response rate. Hence a person-to-person survey was the preferred data collection approach, but this also resulted in a reduced sample size given limited resources available (this paper’s second author was the only person interviewing survey participants). Because of the small sample size, an open-ended format was chosen since the contingent valuation literature suggests that this elicitation format is statistically more efficient than other methods if used in small samples (Boyle et al., 1996; Green et al., 1998).
mainly to agriculture and livestock production, and the risk of water contamination resulting from these activities; (c) the description of a potential management plan for the area that included purchasing the land from private owners, reforestation and protection of the area; and (d) an explanation regarding the fact that the current cost of water only covers treatment and distribution costs. After this statement, the following WTP question was asked: ‘How much more would you be willing to pay in your monthly water bill in order to buy the land of the ‘El Carmen’ and ‘San Simon’ micro-basins to establish a management plan that includes reforestation, protection and maintenance of the area in order to improve the quality and amount of water collected?’

2.3. Regression analysis

Regression analysis was conducted to estimate the influence of several hypothesized variables on households’ WTP for the resource management plan. Given that 15% of the surveyed respondents stated they were not willing to pay anything (i.e. their WTP was $0) for the basin protection plan, a censored Tobit model that controlled for the truncation in the distribution of the dependent variable was used in estimation (Greene, 2003). The Tobit model for this particular application is:

\[
\text{WTP}_i = \begin{cases} 
\beta'x_i + u_i & \text{if RHS} > 0 \\
0 & \text{otherwise} 
\end{cases}
\]

where \( \beta \) is a vector of unknown parameters and \( x_i \) is a conformable vector of explanatory variables for individual \( i \)'s WTP. If the residual \( u_i \) are assumed to be independently and normally distributed, with mean zero and common variance \( \sigma^2 \), estimation of \( \beta \) can be carried out using log-likelihood estimation procedures (Greene, 2003).

Household WTP for the basin protection and maintenance was hypothesized to be affected by the following variables (\( x_{i,j} \)): household socio-economic characteristics, perceptions about the water supply service quality, quantity and price, and perceptions regarding the impact that human activity in the basin watershed has on water quality. Since economic theory, in most cases, does not provide guidance regarding the direction of the effect of households’ socio-economic characteristics and perceptions on demand and WTP models, we contrasted our results to those presented in previous studies. Table 1 presents a complete description of the specification of all variables used in the Tobit analysis.

The average age of the surveyed respondents was 40 years. Fifty two percent of the surveyed individuals were male and 76% reported having some college education (individuals with college degrees or at least some college education), which is consistent with the 2001 National Census that reported that Loja has one of the highest levels of educational attainment in Ecuador. The average monthly household income for all survey respondents was $790, which is consistent with the average monthly income reported by city residents in the 2006 Ecuadorian Living Conditions Survey ($766).  

\[^3\] As is common in several cities throughout the world, the ‘water bill’ or ‘cuenta de agua’ usually includes surcharges for sewage use and trash collection. However, in the case of Loja, it can also include payments for sidewalk construction and/ or road paving. The way the question was worded implied ‘willingness to pay’ in addition to the total monthly payment for all the services, not only for water usage.
Hence, relative to the 2006 average national household income, the average household income in the city was about 30% higher.

Survey respondents pay an average of $19.60 per month for water services. Most respondents (65%) perceive their water bill cost as normal. However, many individuals believe the water service is poor. Seventy-eight percent of respondents stated that the quantity of water supplied was low, 70% perceived the water quality as deficient, and 38% viewed the water supply as unreliable. Even though water was available 7 days a week to all surveyed respondents, 19% of the respondents indicated that daily access to water was less than 6 hours. Respondents believed that poor water quality and intermittent access to water primarily resulted from poor administrative management and poor system maintenance.

Survey respondents recognized the importance of preserving the basins that serve Loja. In fact, 93% of the individuals surveyed believed reforestation of the micro-basins could improve or at least maintain the quantity of water that the two basins then provided. Moreover, 84% believed that the best solution to the problems caused by the presence of private owners residing within the watershed was the purchase of their land. Additional compiled survey information can be found in Arias & Benavides (2005).

Because the estimated Tobit model coefficients do not measure marginal effects, the marginal effects of each estimated coefficient, in addition to the estimated model coefficients, are reported in Table 2. The marginal effect of the vector $x_i$ on the expected value of $WTP_i$ is calculated as (Greene, 2003):

$$\frac{\partial E[WTP_i]}{\partial x_i} = \Phi \left( \frac{\beta' x_i}{\sigma} \right) \beta$$

Table 1. Description of variables used in the regression model ($n = 100$).

<table>
<thead>
<tr>
<th>Variable</th>
<th>Mean</th>
<th>Standard error</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Willingness to pay ($)</td>
<td>5.79</td>
<td>7.72</td>
<td>0–36</td>
</tr>
<tr>
<td>Age (years)</td>
<td>39.89</td>
<td>11.73</td>
<td>17–72</td>
</tr>
<tr>
<td>Occupation</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gender</td>
<td>0.52</td>
<td>0.50</td>
<td>1 = Male, 0 = Female</td>
</tr>
<tr>
<td>Education level</td>
<td>0.76</td>
<td>0.43</td>
<td>1 = College education, 0 = Less than college education</td>
</tr>
<tr>
<td>Family members</td>
<td>4.50</td>
<td>2.04</td>
<td>1–15</td>
</tr>
<tr>
<td>Household income ($ per month)</td>
<td>789.80</td>
<td>648.99</td>
<td>100–4,000</td>
</tr>
<tr>
<td>Household expenditures per capita ($ per month)$a</td>
<td>126.10</td>
<td>130.58</td>
<td>2.5–992</td>
</tr>
<tr>
<td>Water bill ($ per month)</td>
<td>19.61</td>
<td>18.01</td>
<td>3–125</td>
</tr>
<tr>
<td>Access to water 24 hours a day</td>
<td>0.80</td>
<td>0.40</td>
<td>1 = Yes, 0 = No</td>
</tr>
<tr>
<td>Perception about water tariff</td>
<td>0.26</td>
<td>0.44</td>
<td>1 = Expensive, 0 = Normal or cheap</td>
</tr>
<tr>
<td>Perception about water quantity</td>
<td>0.22</td>
<td>0.42</td>
<td>0 = not satisfied, 1 = satisfied</td>
</tr>
<tr>
<td>Perception about water quality</td>
<td>0.30</td>
<td>0.46</td>
<td>0 = not satisfied, 1 = satisfied</td>
</tr>
<tr>
<td>Perception about water service reliability</td>
<td>0.62</td>
<td>0.49</td>
<td>0 = not satisfied, 1 = satisfied</td>
</tr>
<tr>
<td>Potential solution to the presence of private landowners in micro-basins</td>
<td>0.84</td>
<td>0.37</td>
<td>0 = Maintain human settlements and educate them about problems, 1 = Buy land from private owners</td>
</tr>
</tbody>
</table>

*aDoes not include expenditure for water services.

Hence, relative to the 2006 average national household income, the average household income in the city was about 30% higher.

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Because the estimated Tobit model coefficients do not measure marginal effects, the marginal effects of each estimated coefficient, in addition to the estimated model coefficients, are reported in Table 2. The marginal effect of the vector $x_i$ on the expected value of $WTP_i$ is calculated as (Greene, 2003):

$$\frac{\partial E[WTP_i]}{\partial x_i} = \Phi \left( \frac{\beta' x_i}{\sigma} \right) \beta$$

4 Average income values were calculated by the authors using the 2006 Ecuadorian Living Conditions Survey.
where \( \Phi(\cdot) \) is the cumulative distribution function of the standard normal. The asymptotic covariance matrix of both the coefficient estimates and the marginal effects was approximated using the non-parametric bootstrapping procedure outlined by Wooldridge (2002, p. 379). A total of 999 replications were used to generate the standard errors.

### 3. Results and discussion

#### 3.1. Willingness to pay results

The direct responses to the WTP question reveal that mean monthly WTP by Loja households is $5.80 (95% confidence interval $4.27 to $7.30) to finance a basin protection plan. By contrast, the median WTP by Loja residents is only $3 per month (95% confidence interval $2.00 to $5.00), slightly more than half the mean value.\(^5\) The mean and median WTP values correspond to 0.74 and 0.38% of monthly income, respectively. These percentage values are consistent with the lower bound estimates of other studies that have estimated household WTP for improvements in drinking water quality which range from 0.25% to 3.82% of monthly income (Casey \textit{et al.}, 2005; Eisen-Hecht & Kramer, 2002; Johnson & Baltodano, 2004; Shultz & Soliz, 2007; Whittington \textit{et al.}, 1990).

The household mean and median monthly WTP estimates of $5.80 and $3.00 to improve water supply security, respectively, correspond to increases of 29.5 and 15% in the self-reported average Loja household monthly water bill of $19.60. These estimates are less than those estimated in earlier studies comparing different elicitation methods suggest that open-ended WTP estimates tend to be smaller in magnitude than those obtained using dichotomous choice or payment card methods (McFadden, 1994; Boyle \textit{et al.}, 1996; Green \textit{et al.}, 1998). Therefore, our mean WTP estimate can be viewed as a conservative estimate of the true population value.

\(^{5}\) Results of studies comparing different elicitation methods suggest that open-ended WTP estimates tend to be smaller in magnitude than those obtained using dichotomous choice or payment card methods (McFadden, 1994; Boyle \textit{et al.}, 1996; Green \textit{et al.}, 1998). Therefore, our mean WTP estimate can be viewed as a conservative estimate of the true population value.
studies conducted in developing countries where household WTP for improved water supply security more than doubled their current water service payment (Montes de Oca et al., 2003; Rodriguez, 2003; Casey et al., 2005). However, the estimated WTP value is very close to the 20% water consumption surcharge that households in the town of Pimampiro in Northern Ecuador agreed to pay to finance a basin conservation project that is very similar to the project intended for Loja (Wunder & Alban, 2008).

The current monthly household cost for water has a positive effect on household WTP for basin preservation (Table 2). Each additional dollar paid in the current average monthly water bill increases WTP by $0.15 per month. For example, a household that has a monthly water bill of $20 has a monthly WTP of €3, which is $1.50 greater per month than a household with a monthly water bill of $10 and a monthly WTP of $1.50. A higher monthly bill could reflect households’ stronger preferences for water use, hence the positive association between the variables. However, this finding contrasts with Griffin & Mjelde’s (2000) US study that found that households with higher monthly water bills refused to pay more to avoid water shortages than those with a lower monthly water bill. In another US study, Loomis et al. (2000) found that households with a higher monthly water bill are more likely than those with a smaller water bill to vote against a water conservation project that would increase their water bill.

The marginal effect of income is positive but statistically insignificant. This suggests WTP for the basin preservation in Loja is nearly constant across income classes. A positive and significant relationship between income and WTP has been found in other WTP studies for water service improvements (Whittington et al., 1990; Griffin & Mjelde, 2000; Montes de Oca et al., 2003). However, there are also several earlier studies that have not identified a statistically significant effect of income on the WTP for water quality improvements (e.g. Johnson & Baltodano, 2004; Shultz & Soliz, 2007). Flores & Carson (1997) showed that the income elasticity of demand and the income elasticity of WTP for the same good are fundamentally different, and can differ significantly in magnitude and even sign. Thus, a ‘normal’ or ‘luxury’ good in a demand sense may have an income elasticity of WTP that is lower or equal to zero. Hence, our finding of a low and statistically insignificant effect of income on WTP cannot and should not be used to conclude that households’ demand for water quantity and/or quality within the city is not affected by income.

The marginal effects for the six dummy variables included in the regression model, to control for individual characteristics, are measured relative to an individual without the characteristics. Dummy variable are used to control for: (1) the sex of the respondent; (2) households that have access to water for less than 24 hours in a day; (3) respondents who think the current price paid for water is expensive; (4) households that are not satisfied with current water quality; (5) households that are not satisfied with current water quantity; and (6) households that are not satisfied with current system reliability.

Male respondents have a $3.80 higher WTP than females. Individuals who have access to water 24 hours per day have a WTP that is $4 higher than those that receive the service less than 24 hours per day. Individuals who perceive the current water bill as expensive have $4.70 lower WTP than individuals who view the current bill as reasonable or cheap.

6 Though not reported, the model was re-estimated using the ratio of stated monthly household WTP to the current household monthly water bill as the dependent variable. This alternative specification of the model revealed that current monthly household cost of the water service has a negative effect on the percentage increase in the monthly water bill that individuals are WTP for basin protection. That is, despite the fact that in absolute terms households with a higher monthly water bill have a greater WTP for basin protection, in relative terms (when WTP is expressed as a fraction of the current water cost) households’ WTP is smaller.
The gender effect on WTP for water service improvements has not been consistent in prior studies. A study conducted in rural communities in Nicaragua by Johnson & Baltodano (2004) found that males place a higher value on improving water quality and quantity, contrary to other WTP studies for improved water services in Latin America (Perez-Pineda, 1999; Montes de Oca et al., 2003) where females were found to value water service improvements more highly. A possible explanation for the economically and statistically significant effect of gender on WTP is that basin protection, from the respondents’ perspective, could be associated with additional outdoor recreational opportunities which tend to be male dominated activities in the country and region.

Regarding the effect of timely access to water and the perception variables, it is unclear which sign these variables should take. Households that have access to water 24 hours per day are likely to be satisfied with the current service and might not have any motivation to pay for service improvements. However, households currently paying for an inadequate service or a service that is perceived as inadequate may be disinclined to pay even more.

Given that urban households that perceive the existing water price as too expensive have a significantly lower WTP for the basin preservation program, we compared the price of water in Loja to the price in other Ecuadorian cities of comparable size and demographic composition to determine the appropriateness of Loja’s water price. This comparison revealed that, in 2002, the price paid by residential consumers in Ambato was $0.22/m³ and in Ibarra $0.16/m³ (Yepes, 2003). These values are 69% and 23% higher, respectively, than the average price of $0.13/m³ paid by residential consumers in Loja in 2004 and 2005 (Arias & Benavides, 2005). Hence, an increased awareness of water prices in Loja versus other comparable cities might provide additional support for the basin protection and conservation projects.

3.2. Aggregate benefits and costs

In 2006, 24,587 households were connected to UMAPAL’s water system in Loja. Using the estimated average household WTP value of $5.80 per month, the total aggregate value of preserving the two micro-basins is $142,000 per month or $1.7 million per year. If we assume a 10% discount rate and an infinite project life, this translates into a capital value of $696 per household, meaning that Loja residents are implicitly willing to fund a one-time investment of $17 million (to be financed with an additional $5.80 monthly charge over the project lifetime). However, since the WTP estimates do not include commercial and institutional water users, the total regional benefit of preserving the basins will be higher than the estimates presented in this analysis.

The average cost of land in the ‘El Carmen’ and ‘San Simon’ micro-basins area ranges from $300 to $700 per hectare (NCI, 2006). Using an average value of $500 per hectare, the total cost of purchasing the land is $800,000. The costs of protecting and conserving the basin areas have been estimated at $40,000/year (NCI, 2006). The capital value of the costs of protection and conservation of the basin area is $400,000, using the previously mentioned assumptions regarding project life-time and the discount rate. Hence, project benefits exceed the capital value of project cost by more than 14-fold.

3.3. Project implementation

In July 2007, Loja’s city council approved the ‘Ordenanza para la Protección de las Micro Cuencas y Otras Areas Prioritarias para la Conservación del Cantón Loja’ (‘Ordinance for the protection of the
micro-basins and other priority zones for the conservation of Loja County’) (CCL, 2007). This Bill outlined a zoning process that restricts the types of land uses in the micro-basins based on their soil conditions, natural cover and hydrological characteristics and gives the municipality the authority to declare the micro-basins (public and privates) that supply water to the city to be nature reserves. The Bill also imposes an ‘environmental fee’ on water users to finance projects to conserve and protect the basin, such as land expropriation and purchase, monitoring and vigilance, recuperation of the vegetation cover and compensation for environmental services. The environmental fee varies and is based on the volume of water used and the water use category (e.g. $0.03/m³ to $0.07/m³ for residential consumers and $0.07/m³ for industrial users). The average fee paid by residential customers, who account for about 85% of consumers, is about $0.03/m³, or about $1/month.

The aggregate capital value of the imposed fee (nearly $3 million) is sufficient to finance the protection of the micro-basins ($1.2 million). Moreover, by charging water users a fee that is lower than the median WTP, the local government has ensured the support of more than 50% of the population. From the best of our knowledge, the imposition of the fee did not generate public resistance and in fact Loja’s Mayor was re-elected to a new term in office in April 2009 (El Comercio, 2009; Rodas, pers. comm., 2009).

Other local institutions in Loja also support protection of the micro-basins. For example, in 2007 and 2008 the non-profit organization ‘Nature and Culture International’ (NCI) purchased approximately 366 hectares in the ‘El Carmen’ micro-basin using international donations (at an average price of $250/ha). In 2008, NCI turned over the management of the properties to the local government on a 10-year loan-for-use agreement. The municipality is now monitoring and reforesting the areas. Additionally, the municipality is building infrastructure (e.g. trails and camping grounds) so that these areas can be used for recreational and educational purposes (Rodas, pers. comm., 2009). In coordination with NCI, the municipality is also in the process of negotiating the purchase of more land located in the micro-basins.

4. Conclusions

The objective of this study was to estimate the economic value that people living in Loja, Ecuador, place on the protection of two basins, when the protection is designed to improve both the quality and reliability of the water supply for human consumption by the urban residents. The data was collected using a face-to-face survey conducted in December 2005 in Loja, Ecuador. Empirical results indicate that households have an average (mean) WTP of $5.80 per month, a 25% increase in the monthly water bill, to preserve the basins. The main variables affecting WTP were current monthly water cost, perception about the fairness of the existing water price, the number of hours that the service was available, and the gender of the individual interviewed.

Using the aggregate benefit estimate, the feasibility of financing a project to preserve the basins was evaluated. The total cost of the project assuming an infinite horizon was shown to be substantially lower than the aggregate benefits estimated from the WTP survey results. Therefore, the scope of the project could easily be expanded to protect and preserve an additional 1,310 hectares in the two other micro-basins that serve as source for the remaining 67% of water used in Loja (NCI, 2006).

There are other possibilities regarding the project implementation arrangements. An alternative to the purchase of the micro-basins land areas would be a payment to landowners to protect the environmental services provided by the basins without changing land ownership. Arrangements like this have been
successful in other parts of the country (Wunder & Alban, 2008). Both systems should be equivalent in terms of the capital value of the projects but different in terms of cash flows. The consideration of both potential programs by the local government could provide more flexibility for negotiation with the current landowners.

Rapid urbanization in developing countries and the associated demands for new infrastructure services increase the need to invest in new projects, as well as in the operation and maintenance of the current systems (World Bank, 1994; Zerah, 1998). In order to ensure the success and sustainability of these projects, international funding agencies are now stressing the need to obtain resources from domestic consumers (Brookshire & Whittington, 1993). However, local governments are often reluctant to undertake projects that would require increases in utility prices for political reasons or with the intention of helping the poor to have access to the services (Yepes, 1999). The results of this study and the later implementation by the Loja City Municipality of a basin protection project funded through a fee on water users provides evidence that households at all income levels strongly support, and are willing to pay for, a project that has the potential to improve the quality of water services and protect the environment.

This research has also demonstrated that it is possible to use water user WTP for a watershed protection program, designed to improve water supply security, as a tool to determine public acceptance of the associated increased water prices to evaluate the economic, social and political feasibility of implementing such a project. Experiences in other Latin American countries have shown that increased water charges that are not supported by the public can led to violent street protests and civil unrest (Nickson & Vargas, 2002).

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References


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