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The non-market value of reclaimed wastewater for use in agriculture: a contingent valuation approach

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Abstract

The reuse of treated water for agricultural irrigation is considered a promising option in regions facing water scarcity problems and there is an increasing number of reuse projects going on in southern European countries. The aim of this paper is to estimate the non-market benefits that society attaches to the use of reclaimed wastewater for agricultural purposes, as part of the economic assessment needed to evaluate the viability of this water management option. For this purpose, a contingent valuation study has been developed in the Segura River Basin in south-eastern Spain, interviewing 352 individuals from a representative sample of the basin's population. Results show that the use of reclaimed wastewater for irrigation has significant non-market environmental benefits (mean willingness to pay of €5.13 per month per household, which adds up to a total annual value of €23.3 million). In terms of volume, these benefits represent €0.31 m^{-3}. Therefore, it can be concluded that the non-market benefits of using reclaimed wastewater for agriculture justify its implementation, as they overcome the average treatment costs of €0.16-0.26 m^{-3}. Additionally, the analysis of preference heterogeneity suggests that the use of reclaimed wastewater in agriculture is more acceptable to people if they are made aware of their current payment for water sanitation. The inclusion of these non-market benefits in the overall assessment of water policy options will lead to better informed and more efficient water management decisions.

Additional key words: environmental benefits; irrigation; Segura Basin; Spain; Water Framework Directive.

Resumen

Valor no de mercado del uso de agua depurada en agricultura: una aproximación por valoración contingente

El uso de aguas depuradas en la agricultura es considerado una opción prometedora para aquellas zonas que presentan problemas de escasez y de ahí el creciente número de proyectos de reutilización del agua llevados a cabo en los países del sur de Europa. El objetivo de este trabajo es estimar los beneficios no de mercado que la sociedad otorga al uso de aguas depuradas para uso agrícola, como parte de la valoración económica necesaria para conocer la viabilidad de estas opciones de gestión del agua. Para lograr este objetivo se ha realizado un estudio de valoración contingente en la Cuenca del Río Segura, sureste de España, utilizando una muestra representativa de la población de 352 individuos. Los resultados muestran que el uso de agua depurada para regadío genera beneficios ambientales más allá de los beneficios de mercado (disposición a pagar media de 5,13 € por mes y hogar que supondrán 23,3 millones € anuales). En términos de volumen, los beneficios de no mercado relacionados con el uso de las aguas regeneradas en agricultura (0,31 € m^{-3}) justifican su implementación al sobrepasar los costes promedio de tratamiento del agua (0,16-0,26 € m^{-3}). Además, el análisis de la heterogeneidad de la demanda sugiere que el empleo de estas aguas regeneradas sería socialmente más aceptado si los consumidores son informados sobre el pago actual de los servicios de saneamiento del agua. La inclusión de estos beneficios no comerciales en la valoración de la política hídrica global contribuirá a una gestión hídrica mejor informada y más eficiente.

Palabras clave adicionales: beneficios ambientales; Cuenca del Segura; Directiva Marco del Agua; España; regadío.

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Abbreviations used: CEA (cost-effectiveness analysis), CVM (contingent valuation method), EU (European Union), LR (likelihood ratio), RD (Royal Decree),WFD (Water Framework Directive), WTP (willingness to pay).

Introduction

The agricultural sector is the main water user in the Mediterranean area, taking up 50 to 80% of available fresh water (Dworak *et al.,* 2007). Currently, water demand from this sector is increasing and, while other sectors are also likely to increase consumption in the near future, climate change is expected to intensify water scarcity in regions already under water stress (IPCC, 2007). Persistent water scarcity and recurrent —and increasingly frequent— drought episodes have led to the over-exploitation of conventional water resources. The reuse of treated water for agricultural irrigation is considered a promising option in regions facing such problems (Bouwer, 1992; Scott *et al.,* 2004; Birol *et al.,* 2009). According to the European wastewater Directive (OJ, 1991), all wastewater has to be treated before it can be released into the public water domain. However, before treated wastewater can be used in agriculture it requires an additional disinfection treatment, converting it to reclaimed wastewater. In Europe reclaimed wastewater is used for agricultural irrigation, landscape irrigation, industry, groundwater recharge, non-potable urban uses. There are currently about 700 reuse projects in Europe, the majority of which in southern European countries (CIWEM, 2009).

As part of assessing the viability of water management options such as the one discussed here, a comprehensive economic analysis is needed. Within this economic assessment all environmental benefits —including non-market benefits— should be included to ensure an efficient and sustainable allocation of the water resource. This is also in line with the approach taken in the European Union Water Framework Directive (OJ, 2000). The Water Framework Directive (WFD) represents a major regulatory reform and establishes a common framework for the management of water resources within the European Union (EU)[1]. It requires catchment management plans to be in place for all river basins in order to achieve the good ecological status in EU waters. An innovative element of the Directive is the prescription of economic principles and tools for water management. The estimation of all economic costs and benefits of improvements of the ecological status is a required pre-condition for the assessment of the (dis)proportionality of the costs of its implementation (article 4). See Martin-Ortega and Berbel (2009) for a discussion on the role of environmental costs and benefits in the WFD. Also, the WFD requires Member States to elaborate a Program of Measures for River Management Plans (article 11) to bridge the gap between the current status of water bodies and the ecological goals.

Selecting the appropriate scientific tools to assess water policy measures, and, thereby, support complex water management decisions, has been designated as one of the major challenges with regard to the implementation of this European norm (Messner, 2006). For the economic assessment of the environmental benefits of the WFD, a large part of the literature has opted for the use of stated preference techniques. Examples of the application of these techniques are found in the study by Brouwer (2004) for the Scheldt River Basin in The Netherlands, Hanley *et al.* (2006) who apply choice experiments to estimate the benefits of improved water conditions in two rivers in the UK, and Baker *et al*. (2007) for a comprehensive study in England and Wales. Also in the Netherlands, Brouwer (2008) estimated that Dutch citizens' WTP for the expected environmental benefits of the WFD exceeded the costs of its implementation by 22%. In Spain, Del Saz-Salazar *et al.* (2009a), Martin-Ortega *et al.* (2009), Martin-Ortega (2010) and Martin-Ortega and Berbel (2010) estimate the non-market benefits of water quality improvements expected from the WFD in the Serpis and the Guadalquivir basins, respectively. All these studies estimate the welfare changes associated with environmental benefits expected from the implementation of the WFD. This means they focus on the outcomes of the WFD and the expected impact on people's welfare without looking at the measures needed to achieve the ecological objectives.

For the economic assessment of the measures applied to achieve the Directive's goals, cost-effectiveness analysis (CEA) has been proposed (WATECO, 2003)[2]. This approach implies the estimation of the costs of different measures aimed at achieving a pre-established objective. A new set of studies applying this analysis is expected to emerge for the preparation of the Programs of Measures required by the Directive. Such study already exists for the Guadalquivir River Basin in southern Spain (Berbel *et al.,* 2009).

[1] This Directive has been transposed into Spanish legislation (BOE, 2003).

[2] As Messner (2006) points out, although the statements and reports of the WATECO group have only a recommendatory character, they gained acceptance in most national guidelines. For example, see Interwies *et al.* (2004) for Germany; and the Water Planning Instruction for Spain (Orden ARM/2656/2008).

A more policy relevant approach would also be to provide a comprehensive assessment of the benefits — including non-market benefits— at the level of distinct measures. Then the benefits can be compared with the costs of the measures, allowing for a more efficient and sustainable management of water resource. This is what Birol *et al*. (2009) do when they estimate the total costs and benefits of artificial recharge of the Akrotiri aquifer in Cyprus with treated wastewater.

This paper is focused on the improvement of wastewater treatment to make it suitable for reuse in agriculture. The market benefits of this measure stem from avoided losses of agricultural production as a result of water shortages, and increased certainty in water supply. The non-market benefits, which are the focus of this study, relate to the indirect use value associated with locally produced food and the non use values associated with the preservation of the ecological status of the river basin, as well as with the social side effects of employment in agriculture (Birol *et al,*. 2009).

To our knowledge, the non-market benefits of treated wastewater have only been studied in Spain by Hernández-Sancho *et al.* (2009, 2010) who estimate the environmental benefits as the avoided costs of the removed pollutants using distance functions. This method, while being useful and illustrative in some circumstances, cannot be used when the goal is to compare costs and benefits. A better approach is to estimate society's welfare gain resulting from the implementation of a specific measure by eliciting individuals' willingness to pay for the benefits of the measure.

Thus, the specific objective of this study is to estimate the non-market benefits that society attaches to the use of reclaimed wastewater for agricultural purposes, which is expected to play a growing role in areas where conventional water resources are scarce. For this purpose a stated preference technique has been used, *i.e.* the contingent valuation method (CVM). This approach is also consistent with the public participation vocation of the WFD, as it implies the direct gathering of social perceptions and preferences (Brouwer, 2008). This capacity of the stated preference techniques, *i.e.* accounting for public preferences, allows to also analyse the heterogeneity of demand for this measure by accounting for the effect of several characteristics of the respondents on their WTP.

This study, being the first of its kind in Spain and among the first in Europe, is believed to help policy makers with the implementation of water management measures to achieve the WFD environmental objectives in an efficient, sustainable and equitable manner.

Case study description

The Spanish legislation on the reuse of wastewater is fairly recent. It entered into force in 2007 by Royal Decree (RD) 160/2007 (BOE, 2007) which defines water reuse as the effective use of water that has been treated as an effluent from another use. The RD distinguishes between «indirect reuse», when water simply flows back into the public water domain, and «direct reuse», when water is reused in agriculture or industry. When water is rendered fit for reuse it is generally referred to as «reclaimed wastewater» (Iglesias and Ortega, 2008). Reclaimed wastewater is used in five different settings, *i.e.* an urban, agricultural, industrial, recreational, and environmental one. In Spain, 79.2% of the volume of reclaimed wastewater is used by agriculture (Iglesias and Ortega, 2008). For use in agriculture, the RD establishes two physiochemical and two microbiological parameters for reclaimed wastewater with different limits depending on the type of crop (vegetables and fruit trees). The two most important purification treatments to turn treated water into reclaimed wastewater use hypochlorite (53%) and ultraviolet light (43%).

The case study is located in the Segura River Basin in the Spanish south-eastern region of Murcia. In this region, agriculture occupied 565,143 ha in 2007, from which 188,534 were irrigated. The main types of irrigated crops are vegetables (42,571 ha), citrus (38,767 ha) and other fruit trees (27,202 ha) (CARM, 2008). According to the Regional Ministry of Water and Agriculture (*Consejería*), the annual volume necessary to cover the agricultural water needs of the area exceeds 880 hm^3 (CARM, 2007).

The current volume of treated wastewater in Murcia is 101,8 hm^3 yr^{-1} (ESAMUR, 2008), which represents a sixth of renewable resources of the Segura River Basin, and, besides serving other purposes, it supplies 12.8% of the water used for irrigation. In both Spain and Europe, Murcia is a forerunner in the additional treatment and reuse of treated wastewater. Murcia accounts for 45.5% of all reclaimed wastewater in Spain (Batanero, 2008), and in 2010, 66.8% of treated wastewater is expected to undergo an additional treatment to make it fit for reuse (ESAMUR, 2008). As a result, reclaimed wastewater is becoming an important social, agricultural as well as political issue in the region. All this contributes to making this river basin interesting as a case study.

The citizens of this region bear the costs of domestic wastewater purification through a «treatment charge» (*canon de saneamiento*)[3]. The average treatment charge, added to the water bill, comes to €6 month^{-1} household^{-1} [4]. It has been argued that this treatment charge reflects the environmental cost of water use as it can be considered the avoided costs of the damage to the environment (Goodstein, 2008). However, this is a restricted view, based on the consideration of costs as determinants of economic value and thus the welfare losses derived by the deprivation of the environmental good. This is based on the misplaced assumption that costs are necessarily a reasonable approximation of benefits and that the benefits are at least as great as the costs involved in repairing, avoiding or compensating for damage. Such cost based measures of value are derived from the supply of goods and services and should not be confused with demand-based measures.

Methodology

Non-market valuation of water resources

In economics, the value people attach to unpriced natural resources and the services these resources provide is measured in monetary terms through the concept of individuals' willingness to pay (WTP), or, alternatively, willingness to accept compensation. The monetary WTP measure indicates how changes in the provision level of public environmental goods, including quality changes of these goods, impact upon individual welfare. The notion of individual welfare is at the core of neo-classical economic theory. In this theory, values are determined by what individuals want (individual preferences) and measured by the extent to which they are willing to trade off scarce means such as time or money to obtain something (*i.e.* secure a gain), preserve something (*i.e.* prevent a loss) or accept those scarce means in compensation when losing something (*i.e.* either forego a gain or tolerate a loss) (Hicks, 1943). Aggregating individual changes in welfare over all those individuals who are affected by a change in their provision level, provides an indicator of the total economic value of that change (Pearce and Turner, 1990). Depending on the nature of the environmental goods and services, and the type of change involved, different valuation method are available[5]. For environmental goods and services that are not traded in the market, stated preference methods are used to elicit individuals' WTP. These methods imply the use of surveys, in which hypothetical markets are presented to a representative sample of the population. These hypothetical markets are characterized by a change in the environmental good under assessment in exchange for a certain amount of money (Bateman *et al*., 2002).

Despite the numerous applications of the method and its ability to measure non-use values, it is not free of criticism given its susceptibility to estimation errors and strategic answering, *e.g.* due to free rider behaviour (Diamond and Hausman, 1994; Birol *et al.,* 2006). According to Carson *et al.* (2001) the main concerns about environmental valuation either relate to questions about its theoretical basis or to design problems. Eliciting individuals' WTP does not aim at putting a price on environmental goods, but can be used as an indicator of the impact of environmental changes on welfare, which is only meaningful in certain policy contexts. The estimation of the environmental benefits of the WFD is one of those instances where monetary valuation is useful. The Directive itself requires the use of monetary indicators i) for the preparation of the programs of measures, ii) to assist in the full cost recovery of water services, and iii) for determining whether derogation of objectives is acceptable due to disproportional costs. It is important to also include the monetary non-market benefits in these considerations.

The CVM has been used extensively for the valuation of water resources. Interwies *et al.* (2004) provide an interesting survey and review of the field; Loomis (2000) and Birol *et al.* (2006) discuss several CVM studies in the US and Europe; and Schaafsma and Brouwer (2006) review the existing guidelines on the valuation of water resources. Studies that apply non-market valuation of environmental benefits in the specific context of the WFD are, for example, Birol *et al.* (2006), Brouwer (2008), Martin-Ortega *et al.* (2009),

[3] Treatment and purification of wastewater and the implementation of the treatment charge (*Saneamiento y depuración de aguas residuales e implantación del canon de saneamiento*) (BOE, 2000).
[4] Estimated based on an average consumption of 180 L day^{-1} person^{-1} (INE, 2008), and an average of 3 persons per household (CARM, 2008).
[5] For an overview of economic valuation methods see, for example, Freeman (2003).

Del Saz-Salazar *et al.* (2009b) and Martin-Ortega and Berbel (2010).

Structure of the questionnaire

The questionnaire was designed using information obtained from the literature, and through expert consultation and focus group discussions and two rounds of pre-testing.

It consists of three parts. First, respondents were asked general questions about their socio-economic situation. The second part contains questions about respondents' knowledge of the current state of treated wastewater and its use, and their relationship to the river's water, *e.g.* whether they recreate on the river or not. The last part of the questionnaire contains the valuation questions. In this part, respondents were informed about the amount of money they currently pay for the treatment of wastewater. Thereafter, they were asked if they would, in principle, be willing to pay more to raise wastewater purification up to a level that would make the water suitable for use in agriculture, contributing to the preservation of the river's ecological status by reducing the pressure over the resource, at the same time that ensuring water supply for agriculture. For those willing to pay in principle, the maximum amount they were willing to pay was elicited through an open-ended question. The open-ended approach differs from the most commonly endorsed dichotomous choice elicitation format, which was also recommended in 1993 by the National Oceanic and Atmospheric Administration Panel (Arrow *et al.,* 1993). One of the reasons for the preference for the dichotomous choice format in the literature relates to the difficulty for respondent to have an *a priori* idea of their WTP for unfamiliar environmental goods and services (Carson *et al.*, 2001). In the pre-test phase it was checked that the public was familiar with the payment for water services (they currently pay a water bill) and that they were able to provide reliable WTP values through the open ended elicitation format. It has been argued that this format provides higher levels of certainty of stated WTP (Ready *et al.*, 2001) and leads to a lower hypothetic bias (Balistreri *et al.*, 2001).

The payment vehicle was an increase in the monthly water bill. This proved to be the most appropriate option during the design stage of the survey as respondents were already familiar with this kind of payment. Its mandatory character also helps prevent free-rider behaviour of respondents (Del Saz-Salazar *et al.*, 2009a).

Sampling procedure and sample description

The survey was administered by trained enumerators in the city of Murcia during October 2008. Taking into account pre-set quotas for age and sex, 352 respondents were randomly selected.

Respondent characteristics are presented in Table 1. To ascertain the representativeness of the sample, χ^2. tests have been performed, comparing the sample with the entire population of Murcia. For none of the variables a significant difference was found (all $\chi^2 > 0.05$). Respondents had an average age of 40, and 54% of the sample consisted of women. The most commonly selected income categories were «less than €1,000» (32% of respondents) and «€1,000-1,500» (25%). The higher income categories, *i.e.* «€1,500-2,000»; «€2,000-2,500»; and «more than €2,500» were all selected by between 14 and 15% of the respondents. Individuals with a high education level (university) are slightly overrepresented in the sample. However, as will be shown later, this variable does not influence WTP. Overall, the sample is a good representation of the case study area population.

The model

When analysing data with a high variation, which is the case with contingent valuation where there is a large accumulation of zero values, standard lineal regressions (OLS) provide inconsistent WTP values (Seung-Hoon *et al.*, 2000). In these cases, Tobit models have been proposed instead (for example, see Amemiya, 1984; Halstead *et al.*, 1991; Adams *et al.*, 2008). This type of model also allows the analysis of preference heterogeneity among respondents. In a Tobit model the dependent variable is restricted around a certain value (in this case around the zero value) (Tobin, 1958).

The model specification is given by the following censoring rule:

$$y_i = \left\{ y_i^* \text{ if } y_i^* > 0, \quad 0 \text{ otherwise} \right\} \qquad [1]$$

where y_i is the stated WTP of respondent i and y_i^* is the corresponding latent value of the respondent's willingness to pay. This expression represents the situation in which zero responses are generated from the same

Table 1. Description of the variables used in the analysis

Variable	Sample	Murcia region	χ^2
Respondent age	40.68	37.28	0.37
18-34 years (population share; 1)	36.36	34.84	
35-59 years (population share; 2)	50.00	42.60	
≥ 60 years (population share; 3)	13.64	22.56	
Sex (1 = male; 0 = female)	53.90	50.47	0.16
Education (population share)			0.20
Primary education or lower (0)	22.95	49.50	
Secondary education (1)	36.07	36.80	
Higher education (2)	40.98	21.10	
Monthly income (population share)			0.22
< 1,000 € (1)	32.35	37.70	
1,000-1,500 € (2)	24.51	12.40	
1,500-2,000 € (3)	15.36	16.60	
2,000-2,500 € (4)	13.40	18.90	
> 2,500 € (5)	14.38	14.40	
Size of the household	3.42	3.15	0.26
Children in the household (1 = yes; 0 = no)	56.82	—	
Visits the Segura river (1 = yes; 0 = no)	85.51	—	
Do you know how high the monthly water bill is? (1 = yes; 0 = no)	63.29	—	
Do you know the average monthly wastewater treatment charge is €6 (1 = yes; 0 = no)	15.27	—	

process as nonzero responses that represent compensating surplus. The expected value of the latent variable y_i^* and the marginal effects in the model are expressed as:

$$E(y_i^*|x_i) = \beta' x_i \qquad \partial E(y_i^*|x_i)/\partial x_i = \beta \quad [2]$$

where x_i is the vector of the explanatory variables and β is the parameter determining the impact of the explanatory variable on the WTP. The Tobit model represents the expected value of the variable y_i as:

$$E(y_i^*|x_i) = \beta' x_i F(z) + \sigma f(z), \quad [3]$$

where $z = \beta' x_i / \sigma$, f(z) is the density function, F(z) is the cumulative distribution function of a standard normal random variable and σ is the standard deviation. Then the marginal effects in the model are given by:

$$\partial E(y_i|x_i)/\partial x_i = F(z)\beta \quad [4]$$

where i is the number of respondents, β is the vector of coefficients to be estimated for the individual respondent characteristics (x_i) and ε is the error term, which is assumed to have a normal distribution centred around zero.

Results and discussion

An analysis of the underlying reasons why respondents were not willing to pay was carried out in order to distinguish legitimate zero bidders from protest bidders. Legitimate zeros bidders correspond to individuals who attach zero value to the environmental change. Protest bidders do not necessarily have zero values but reject the valuation exercise (Hanley, 1996). Protests answers were distinguished from legitimate zero bids by means of follow up questions about the reasons respondents were not willing to pay[6]. The standard procedure in CV, and the one followed in this study, is to remove protest responses from the analysis (coding them as missing values) in order to obtain estimates that are unbiased by the protesters (Whitehead *et al.*, 1993; Jorgensen *et al.*, 1999; Dziegielewska and

[6] In our study legitimate zero answers include respondents who «do not think the good is important», «cannot afford to pay extra», «prefer to spend the money on other things», or «feel they pay enough already». «It is a problem of the State», was considered a protest against the payment vehicle.

Mendelsohn, 2007). In this case, 22.72% of the total sample (80 respondents) were identified as protest bidders and 6.25% (22 respondents) as legitimate zeros. Therefore 272 observations were preserved from the original 352 interviews to perform the consequent analyses.

Around 15% of respondents are aware of the amount of money they currently pay for the treatment of wastewater, which amounts to €6 per month for an average household (ESAMUR, 2009). On average, people are willing to increase this amount, over the current payment, by €5.13 (95% confidence interval: €4.48-5.78) per month per household or €61.58 annually. Translated to the water tariff, and taking into account the average monthly water consumption per household in this region, this comes to €0.31 m^{-3} (95% confidence interval: €0.27-0.35 m^{-3}). After aggregating these results over all households (378,252) in the region of Murcia, the benefits of additional purification of treated wastewater to allow for its use in agriculture has a total annual value of €23.3 million.

Heterogeneity of demand for additional treatment of wastewater has been analysed in terms of the socioeconomic characteristics of the respondents as well as in terms of their knowledge of the current use of treated wastewater. Besides analysing a general model that includes all variables (model 1), a leaner second model that only contains those variables that were significant at the 90% level in model 1 has been estimated (model 2). Both models are presented in Table 2.

A likelihood ratio (LR) test of both models confirmed that model 2 better fits the data (LR = 0.52; $\chi^2_{0.05,3} = 7.82$).

The sign of the estimated coefficients indicates whether the variables have a positive or negative effect on the WTP. For example, the coefficient for age has a negative sign, indicating that an older person *ceteris paribus* is willing to pay less than a younger person. Similarly, respondents from larger households also are willing to pay less than respondents from smaller ones. One possible interpretation is that larger households will already have a higher absolute water bill and therefore are possibly less willing to have it increased.

The variable that reflects knowledge about the amount on the monthly water bill also has a negative sign, indicating a lower willingness to pay among those respondents more aware of their current water bill. Possibly, this is due to the fact that the price of water in this region (€1.37 m^{-3}) is among the highest in Spain. However, this result is not in line with what was found by Martin-Ortega *et al.* (2009) and Del Saz Salazar *et al.* (2009b) who also studied the effect of the awareness of the current water bill on WTP for water quality improvements.

A more meaningful result is that people knowledgeable about the level of the treatment charge for wastewater purification, as part of the water bill, are willing to pay more for the additional treatment than those who do not know how much they currently pay for this treatment.

Table 2. Results of the Tobit models

Variable	Model 1		Model 2	
	Coefficient[1]	SE[2]	Coefficient[1]	SE[2]
Age	–0.07*	0.04	–0.07**	0.04
Sex	0.54	1.01		
Education	0.33	0.68		
Income	0.72*	0.41	0.83**	0.37
Household size	–0.74*	0.50	–0.74*	0.44
Children	–0.05	1.11		
River visits	2.88*	1.56	2.90*	1.56
Knowledge water bill	–2.15*	1.20	–2.14*	1.17
Knowledge treatment charge	2.91**	1.46	2.98**	1.45
Constant	5.70*	3.39	6.90**	2.50
Log-likelihood	–876.47		–876.73	
LR(Chi)	16.06		15.53	
Prob > χ^2	0.065		0.016	
No. of observations	268		268	

[1] * $p < 0.10$. ** $p < 0.05$. [2] SE: standard error.

As expected from the theory, income has a positive effect on WTP. Similarly, people who use the river recreationally are willing to pay more than people who do not. This is on line with the frequently observed fact that users of an environmental good hold this in higher value than non-users (Bateman *et al.,* 2006).

In general, the above mentioned results are coherent with earlier Spanish water valuation studies (Martin-Ortega, 2008; Del Saz-Salazar *et al.,* 2009a,b; Martin-Ortega *et al.,* 2009), except for the abovementioned negative effect on WTP of respondent awareness of the current water bill.

Conclusions

The research presented here is aimed at assessing the non-market environmental benefits of one specific measure, *i.e.* the additional treatment of wastewater to allow for its use in agriculture. The non-market benefits of this measure are the contribution to preserving the river's ecological status by reducing the amount of water taken directly from the river for irrigation, while at the same time ensuring a continued water supply for the farmers. Applying stated preference techniques allows the measurement of the total economic value of the service, avoiding the risk of under-valuation of water resources and hence their under-provision. Also, this benefit-based approach is more useful when aimed at the comparison with the costs of the measures. This approach has been illustrated for the case study of the Segura River Basin in south-eastern Spain, where water scarcity problems are among the most severe in Europe and where irrigated agriculture is one of the most important economic sectors. Moreover, important economic efforts have been carried out in this basin in order to improve wastewater quality and reuse.

The study has proven that the local population obtains significant social non-market benefits from this form of water reuse, expressed via the willingness to increase the amount of money paid for this purpose. An average WTP value of €5.13 month^{-1} household^{-1} was obtained. This implies that the population is willing to almost double the €6 treatment charge that is currently added to the average water bill.

The treatment one cubic metre of reclaimed wastewater in Murcia costs between €0.16 and €0.26 according to the wastewater management public authority. In this study the estimated non-market benefits was €0.31 m^{-3}. Therefore, even without taking into account any market benefits, *e.g.* avoided agricultural production losses as a result of water shortages, the non-market benefits would already justify the implementation of the measure in economic terms.

The analysis of the underlying factors influencing the individual WTP for this measure tells us that being aware of the current payment for water sanitation leads to a higher WTP. This is a relevant policy result in the context of the WFD. The Directive prescribes that water tariffs should be examined to ensure the full cost recovery of water services. The results show that people are generally willing to pay more for additional water treatment, but that communication campaigns informing the public about the current water sanitation payment would help to make a possible rise in the treatment charge more socially acceptable. This kind of result supports the claim that stated preference techniques are in line with the vocation of the WFD for public participation.

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