Benefit transfer and spatial heterogeneity of preferences in the valuation of water quality improvements at the river basin level

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Abstract

The implementation of the Water Framework Directive is expected to generate substantial non-market benefits which need to be accounted for the assessment of the (dis)proportionality of the costs of its implementation. Benefit transfer will be needed in this context. In this research, we advocate for the use of spatially sensible valuation designs in which accounting for spatial heterogeneity of preferences helps to generate moderate transfer errors. We estimate the transfer errors produced when assessing the non-market benefits of the improvement of the water quality in a whole river basin on the basis of the stated willingness to pay of the inhabitants of different sub-basins. We apply a choice experiment using maps to elicit non-market welfare measures for water quality improvements in the Guadalquivir River Basin (southern Spain), accounting simultaneously for the spatial distribution of both the improvement in water services and their beneficiaries. Transfer errors across the different sub-basins are calculated based on the welfare measures obtained via a Random Parameter Logit model. We obtain an average transfer error of 11.3%, which is fairly low according to the existing literature.

Key words:

Environmental benefits, choice experiment, value transfer, Water Framework Directive, spatial heterogeneity

JEL Classification:

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1. Introduction

The Water Framework Directive (WFD onwards) (2000/60/CE) is a major regulatory reform of water resources management in which integrated management plans must be prepared for river basins in order to achieve 'good ecological status' in all European waters. In view of its ecological premises, the implementation of the WFD is expected to generate substantial non-market benefits, especially related to non-use values (Bateman *et al*., 2006a; Brouwer, 2008). The economic valuation of these benefits is necessary for the assessment of the (dis)proportionality of the costs of its implementation and the eventual derogation of the Directive's objectives (i.e. the costs of implementation need to be compared with all the benefits generated by the achievement of the good ecological status, including non-market benefits). Moreover, policy-makers are also in need for additional non-cost based information to prioritize their limited budgets across the most valuable sites providing ecosystem services (Brouwer, 2008).

This assessment is currently under-going and the literature is showing progress by applying stated preferences techniques. See Birol *et al*. (2006) and Brouwer (2008) for a discussion of the role of economic valuation techniques in the context of the WFD; and Hanley *et al*. (2006a), Del-Saz Salazar *et al*. (2009), and Baker *et al*.(2007) among others, for specific applications.

However, these studies remain restrictive to certain experimental areas. Primary valuation studies are costly both in time and money and require quite a sophisticated level of expertise to be applied. It is unrealistic to expect stated valuation applications at the river basin level for all European water bodies. Benefits transfer methods will be then needed in implementing the Directive (Hanley *et al*. 2006b). Value transfer exercises typically involve estimating the value of a given change in provision of an environmental good at some target "policy site" from an analysis undertaken at another "study site".

At the same time, it is well accepted that the physical representation of the natural capital in the territory contributes to generate more accurate indicators of the effects of environmental changes on welfare [Johnston *et al*. (2002) and Brody and Highfield (2004)]. Nevertheless, relatively little attention has been given up to date to the spatial dimension in the analysis of environmentally related welfare changes in general [Bockstael (1996), Eade and Moran (1996), Bateman *et al*. (2006b), and Hein *et al*. (2006)] and in the context of water quality valuation in particular (Schaafsma and Brouwer, 2006) – with the exception of the analysis of distance-decay effects in contingent valuation research (e.g. Hanley *et al*., 2003; Bateman *et* *al*., 2006b). The spatial dimension is of particular relevance in the context of the WFD. The WFD establishes the river basin as the essential unit of management in water policy. This imposes a geophysical (and thus spatial) approach for the achievement of the ecological aims. The WFD requires river basins to be treated as a whole in water management plans (Hanley *et al*. 2006b) and valuation studies need to be spatially sensible in order to produce accurate monetary estimates (Brouwer *et al*. 2010).

The aim of this study is to estimate the transfer errors when accounting for the spatial heterogeneity of preferences at the river basin level. For this purpose, we apply a choice experiment (CE) using maps to elicit non-market welfare measures for water quality improvements in the Guadalquivir River Basin in the south of Spain, accounting simultaneously for the spatial distribution of both the improvement in water services and their beneficiaries. This way, we expect to reduce transfer errors by explicitly designing the valuation based on the spatial link between individuals and the site. This is based on the approach of building up transfer functions from theoretical principles, focusing upon factors which are likely to be determinants of WTP at all sites (Brouwer and Bateman, 2005) an not on very site-specific determinants. We will argue that the spatial relation-ship of the beneficiary and the valued good is one of these core characteristics with a similar relationship with WTP values across sites.

The remainder of this paper is organized as follows. Next, in Section 2, the literature on value transferability is presented, with special focus on water studies. The Guadalquivir river basin case study, is described in Section 3. Sections 4 and 5 describe the applied methodology and survey design, while section 6 presents the main results. Conclusions presented in Section 7.

2. Value transferability

In the water policy context, the demand for environmental valuation estimates is rising with the introduction of the WFD since it requires benefit-cost analysis of water quality improvements throughout the European Union. However, the reliability of this technique is still under development in the specific case of the WFD. Hanley *et al*. (2006b) recommends that policy makers should proceed with caution in transferring benefit estimates for water quality improvements under the WFD.

Benefit or value transfer can be defined as the use of existing valuation information for one or more environmental goods or services to estimate the unknown value of a similar good or service (Hanley *et al*., 2006b). Economic information captured at one place and time is used to make inferences about the economic value of environmental goods and services at another place and time. Monetary estimates can be transferred as univariate transfers or as function transfers (Colombo and Hanley, 2008). Univariate transfers consists on monetary value units (such as mean WTP), while value functions are estimated with statistical techniques with the study site data and thus depend on the explanatory variables that define the attributes of an ecological and economic choice setting (Wilson and Hoehn, 2006). Value functions can be estimated using data from the original studies (Loomis, 1992), or by using a meta-analysis from several case studies on similar sites [Wooddward and Wui (2001; Bateman and Jones, (2003); and Rosenberger and Loomis (2000)]. Using study sites that are similar to the policy site and transfer mean values from the former to the latter is a recommended and very useful approach for political decision making (Muthke and Holm-Mueller, 2004).

Value transfer has both its advantages and disadvantages. On one side, given the amount of work done on primary valuation it is very important for the policy practice to use this stock of knowledge in the practical policy decision making. However, assessing whether a given transfer is correct or not is always problematic since no information about the true value of the policy site is normally known. According to Hanley *et al*. (2006b), there are several reasons why there is no consensus about the accuracy of the value transfer techniques. First is the low number of valuation studies collected in databases. Second is the discussion on the principles of transfer and third is on the methodology to apply value transfer.

The assessment of transfer validity is tested by calculating transfer errors. Transfer errors are calculated as the difference between the value for a site as estimated from the sites compared with the value of that site as estimated from its own data. Rosenberger and Stanley (2006) identify three categories of benefit transfer error and examine the extent to which these three errors arise in empirical research. First is the generalization error, and arises from differences between the study site and the policy site. Second is the measurement error, and stems from the judgments and methods used in the original study. Third is publication bias, since economic journals give more attention to methodological innovations than to reporting conventional benefit estimation studies. Based on these errors, Loomis and Rosenberger (2006) propose three criteria to follow for valid benefit transfers, focusing on how original studies should report these results for potential benefit transfer. The three criteria they propose are: commodity definition comparability; market area comparability and welfare and empirical benefit measure comparability. Based on these criteria, many studies have been implemented in order to measure transfer errors. Table 1 presents examples of water related valuation studies and the estimated transfer errors.

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In building up value functions for transfer purposes, analysts have tended to include the variables elicited in the stated preferences survey trying to produce models upon statistical Best-fit principles. However, functions based on statistical best fit principles usually incorporate variables peculiar to the specific sites and using them for value transferability can produce higher errors. For example, there are studies in the literature in which univariate transfers proved to generate lower errors than transfers based on value functions (Barton, 2002; Ready *et al*., 2004; Bateman *et al*., 2009). For this reason, Brouwer and Bateman (2005) advocate for the inclusion only of factors that are theoretically likely to be relevant to all contexts as they are common elements of underlying utility functions. This can include: i) change on provision (water quality change), ii) theoretically expected characteristics of the individual (income) and iii) core characteristics of the site. Here we propose the spatial relationship between the beneficiary and the valued good as one of these core characteristics of the site. Evidence of the effect of spatial consideration in WTP values is discussed next.

3. Value transferability and spatial considerations

We find in the literature evidence of the effect of spatial considerations regarding the environmental change and the transferability of values. Morrison and Bergland (2006) conducted a review on the validity of benefit transfer from choice experiments and concluded that there is evidence on the sensitivity of value estimates to population and site differences. On an earlier study, Morrison and Bennett (2004) conducted a choice modeling approach to value the water quality improvement of seven specific catchments in the New South Wales Rivers. Values estimated were found to differ across catchments when populations resident within catchment were sampled. In the same line, Bateman *et al*. (2006b) signalled that preferences and values for water quality improvements are expected to be, at least in part, determined by the spatial distribution of the beneficiaries involved throughout the river basin where the water quality improvements are foreseen. At a larger scale than the river basin, Bueren and Bennett (2004) studied the validity of transferring benefits generated at a national context to a regional context, obtaining that all the implicit prices generated at a regional context exceeded those generated at a national context. They explain their results by defending that respondents were willing to pay more for an improvement to occur in their own region than on the entire nation.

From this review we can conclude that there is evidence on the fact that accounting for spatial considerations has an effect on the transferability of values, but as Colombo and Hanley (2008) subscribe, more research should be developed in this respect. While studies introducing spatial considerations in value transfer have observed high sensitivity of values to sites, more research is justified in this line to improve the reliability of value transferability, especially for policy purposes. The present work contributes to this need and presents an exercise of transfer errors at a river basin level where the place of residence is used as a spatial core characteristic of site in relation with the beneficiary. The hypothesis being that the population values differently the water quality improvement depending where it takes place in relation to where they live and that this relationship (zone of residence – WTP) holds across sites. Controlling for this core characteristic of the site in relation to the beneficiaries is expected tto produce moderate transfer errors.

3. Case study description

The Guadalquivir River Basin (GRB) is the longest river in the south of Spain with a length of around 650 km. The GRB covers an area of 57.527 km^2 with a population of over 4 million people. The basin has a Mediterranean climate with a heterogeneous precipitation distribution. Annual average temperature is 16.8°C and average precipitation 630mm. Natural annual flow levels are 6,900 Hm^3 for surface water and 2,576 Hm^3 for groundwater (Confederación Hidrográfica del Guadalquivir, 2009). About half of these water flows are used for human consumption, mainly in agriculture (>80%) (Gutiérrez *et al*. 2009). Per capita water consumption in the GRB in 2005 was 1,600 m^3. Water consumption is expected to increase with 5 percent in the next years (Martín-Ortega *et al*., 2008). Water quality is also a significant problem throughout the river basin. The main sources of pollution include urban and industrial wastewater discharge, erosion, nutrient and pesticide run-off from agriculture. Concentration levels of Nitrogen and Phosphorous, heavy metals and organic pollutants in surface and groundwater are expected to increase with about 30% in the near future (Gutiérrez *et al*. 2009).

For the purpose of this study, the GRB is divided into four distinct sub-basins: *Sierra Morena and Alto Guadalquivir* in the north (hereafter *'Alto'*), *Valle del Guadalquivir* in the centre of the basin (hereafter *'Valle')*, *Campiña* in the south and the *Doñana National Park* at the mouth of the Guadalquivir river in the south-west (hereafter *'Doñana')*. The sub-basins differ in terms of water quality levels, but also in terms of the relative homogeneity of the landscape, land use and population density. *Alto* can be characterized as a mountainous low populated, extensive agricultural area. *Valle* is the valley through which the main Guadalquivir river stream flows, highly fertile with intensive agricultural land use and the highest population density, concentrated in the cities Sevilla, Cordoba and Granada, and some of the biggest industrial areas in the region. *Campiña* has a low-land agricultural landscape with a number of medium-sized cities. Finally, *Doñana* is home to a wide variety of rare protected species like the Iberian lynx and the Imperial eagle[1]. The zones were selected in order to test transferability across relatively dissimilar areas within the river basin as a benchmark for likely situations in Europe. This way, we can see through this study whether taking into account spatial considerations produces moderate transfer errors, even among areas holding different land characteristics within the same river basin.

The water quality levels used in this study (poor, moderate, good, very good) are based on the categorization of water bodies in the WFD, and described along the lines of the US EPA water quality ladder (e.g. Carson and Mitchell, 1993) in terms of their consequences for different types of water use. Moderate water quality is described in terms of suitable for sprinkling gardens and irrigation, good water quality as suitable for recreation like swimming and fishing, and very good water quality as suitable for drinking water and reflecting a complete natural state of the water environment. This latter level is assumed here to correspond to the good ecological status (GES) prescribed by the WFD. As in the original water quality ladder applied by the US EPA, each level includes the quality characteristics of the level below. Bad level corresponds to a deteriorated environment and does not allow for any of the above mentioned uses. Different forms of the water quality ladder have been used in the context of the WFD [see Bederli and Brouwer (2007) and Del Saz-Salazar *et al*. (2009)]. This approach was understood best by lay public. During the pre-tests, a technical description of water quality levels based on physical indicators was too hard to understand for the general public and may have resulted in non-significance of the attributes as in Hanley *et al*. (2006a)[2].

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[1] For the purpose of this study, the zone Doñana is considered as not populated, refereeing to the National Park, although in the pictograms it appears with wider borders with respect to the non-populated area, for the sake of visibility and clarity.

[2] Approaches alternative to the water quality ladder have also been successfully applied like the one used by Baker et al. (2007), in which a simple metric of ecological status with no detailed qualitative description of the improvement is used.

Using the above mentioned geographical division of the river basin and the water quality ladder, the current situation in the GRB is presented in Figure 1. The map was developed in collaboration with the GRB authority (*Confederación Hidrográfica del Guadalquivir*).

INSERT FIGURE 1 HERE

4. Methodology

Choice experiments such as the one presented here have their roots in random utility theory (e.g. McFadden, 1974; Ben-Akiva and Lerman, 1985). The multinomial logit model (MNL) is the most commonly used structure for choice models, but is often rather restrictive in practice. The random parameters logit (RPL) is more flexible and relaxes the assumption of independence of irrelevant alternatives (IIA) as a result of the iid property underlying MNL (Train, 2003), and allows for preference heterogeneity. According to McFadden and Train (2000), any random utility model can be approximated by a mixed logit model. The standard indirect utility function underlying the mixed logit model is:

$$U_{ij} = V_{ij} + \varepsilon_{ij} = \beta_i X_{ij} + \varepsilon_{ij} \qquad (1)$$

where U_{ij} refers to the utility of individual *i* obtained from choice alternative *j*, V_{ij} is the measurable component of utility measured through a vector of utility coefficients β associated with a vector of observed attribute and individual characteristics X_{ij}, and ε_{ij} captures the unobserved influences on an individual's choice with an iid extreme value distribution. The utility coefficients β vary according to individual (hence β_i) with density $f(\beta)$. This density can be a function of any set of parameters, and represents in this case the mean and covariance of β in the sample population:

$$U_{ij} = \beta X_{ij} + f(\beta) X_{ij} + \varepsilon_{ij} \qquad (2)$$

Mixed logit models assume heterogeneity to be continuous over the interval spanned by the assumed distribution for the taste parameters (Scarpa *et al.*, 2005).

Choice experiments are argued to have a number of distinct advantages compared to other stated preferences techniques such as contingent valuation (Hanley *et al.*, 2001), including superior conditions for benefits transfer given its ability to better control for differences in good and site characteristics through the use of attributes (e.g. Morrison *et al*., 2002)[3].

In the context of benefit transfer, allowing for variation in preferences across individuals helps mitigating miss-specification of the derived welfare estimates (Hanley *et al*., 2006b). Moreover, Colombo *et al*. (2007), who studied the costs of soil erosion in Southern Spain employing a choice experiment in two neighboring catchments, found that by including respondents' heterogeneity using a random parameters approach, the transferred errors of welfare measures for policy alternatives to reduce off-site impacts from soil erosion were significantly reduced. Transfer errors were compared between the two catchments resulting into average transfer errors much smaller with random parameter than with conditional logit model: 66% versus 154%.

With the purpose of accounting for the spatial heterogeneity of people's preferences for transferability purposes, we define the alternatives in the CE in terms of water quality improvements in the specific sub-basins within the Guadalquivir River Basin ('Alto', 'Valle', 'Campiña' and 'Doñana'), which can be realized at a certain price. The alternatives are presented as possible policy scenarios between which people are asked to choose compared to the baseline or 'status quo' option to different levels of water quality improvement in the different areas throughout the entire basin. Thus the attributes of the choice experiments are defined as the improvement of water quality per zone. See Table 2 for a full description of the attributes and their levels[4]. Details on the experimental and survey design are given in the next section.

INSERT TABLE 2 HERE

In this study we estimate the transfer errors in which one would fall into when estimating the non-market benefits of the improvement of the water quality in the whole river. This is done on the basis of a spatially sensible valuation scenario, in which the relationship between where the beneficiary lives and where the environmental change takes place is accounted for.

In general, heterogeneity of preferences is accounted for in choice experiments by the interaction of explanatory variables with the alternative specific constant or the attributes

[3] It should be mentioned, however, that there is still scarce empirical evidence of this superiority of CE versus CV for value transferability. There are very few studies that apply both CE and CV on a comparable basis, i.e. identical valuation scenarios for the same environmental change (Foster and Mourato, 2003).

[4] It should be noticed that only improvements, and not worsening, with respect to the baseline situation were allowed, as the prescription of the WFD is to increase the ecological status of water bodies.

(water quality improvement in an specific area of sub-basin) of the model (Rolfe, *et al.*, 2000). In our study, spatial heterogeneity of preferences is accounted via the interaction of the attributes with the zone of residence.

Based on the choice design used in this case study, equation (1) can then be rewritten as (3):

$$V_{ij} = \alpha + \beta_{qs} Q_{sij} + \beta_p P_{ij} + \beta_y Y_{ij} + \beta_{zr*z}(Zr * Z) + \varepsilon_{ij} \qquad (3)$$

where α is the constant, β_{qs} the vector of coefficients attached to the water quality attributes Q in sub-basin s (model attributes)[5], β_p the price vector, and β_y the coefficient related to the households income Y_i; and β_{zr} is the vector of coefficients related to the interaction terms between zone of residence of the individual (Z_r) and the zone where the environmental change takes place (Z).

Based on this model specification, WTP values attached by the inhabitants of the different sub-basins to the improvement of the water quality of the *whole* river basin from the baseline situation to the very good level are estimated. Transfer errors (e) between the values of inhabitants of different zones are calculated as proposed by Brouwer and Bateman (2005) (4):

$$e = \left| \frac{WTP_i - WTP_j}{WTP_j} \right| * 100\% \qquad (4)$$

Where WTP_i is the value given to the improvement of the whole river basin by inhabitants of zone i and WTP_j is the same value given by inhabitants of zone j.

5. Survey design and sampling strategy

Structure of the questionnaire

The questionnaire used in the survey consists of three main parts. In the first part, respondents were asked about their perception of water-related problems, their professional and recreational water experiences, and their opinion related to water quality.

In a second step, respondents were interrogated about their preferences and values towards water quality improvements in the GRB. Firstly if they were willing to pay in principle to improve the water quality in the Guadalquivir river basin in order to identify protest responses

[5] In the RPL the coefficient of the attribute is allowed to be random with density *f*(β).

from legitimate zeros[6]. Secondly respondents were presented with the choice experiment to determine the maximum amount of money that they will be willing to add annually to their water bill[7] during the next ten years to ensure the improvement of the water quality in the whole GRB to the very good level of water quality –which is assimilated here to the 'good ecological status'. For this purpose, a main effects fractional factorial design consisting of 36 choice sets was generated, i.e. 9 versions of 4 cards. We account for differences in the baseline situation in the sub-basins (Alto, Valle, Campiña and Doñana). Situation A and B represent improvements with respect to the baseline situation, i.e. water quality in each sub-basin is equal to or better than the baseline situation (see Figure 2 for an example of choice card). The cost price has 6 different levels (€10, €25, €50, €75, €100, €150) to be added annually to the household water bill. The cost, to be paid through the household water bill, in the status quo is therefore zero.

INSTERT FIGURE 2

Finally, a third section of the questionnaire gathered information concerning respondents' demographic and socio-economic characteristics.

Sampling strategy

Over 600 face-to-face interviews were conducted by a local sampling company in October 2006 throughout the GRB, targeting a random sample of the urban and rural population. The questionnaire was pre-tested at length over a period of 5 months based on two focus groups and 100 face-to-face interviews.

The main demographic and socio-economic characteristics of the sample (n=619) are presented in Table 2. The sample provides a cross-section of the total population in the Guadalquivir river basin as can be seen from the river basin population statistics.

INSERT TABLE 3 HERE

[6] Legitimate zero answers include respondents who: "don´t think the good is important", "cannot afford to pay extra", "prefer to spend the money in other things", consider that he/she "already pays enough". Protest answers include: "The polluter should pay", "water is a natural resource, it should be free", "I don't trust the system" and "it is a problem of the State".

[7] During the pre-testing process three payment vehicles were tested: yearly water tax for water quality, monthly water bill increase and yearly water bill increase. The later was the one resulting on a lower rate of payment vehicle protest answer (3% versus 8 and 4% for the tax and the bimonthly water bill increase).

Average household income is higher (20%) in the sample than in the population from which it was drawn. The same applies for the number of people with a higher education level. However, we consider that this is still a good representation of the target population.

6. Results

Modelling results

Protest answers were excluded from the WTP analysis, as common practice in the literature (see Whitehead *et al*. (1993), Mitchell and Carson (1989) and Jorgensen *et al*. (1999), Dziegielewska and Mendelsohn (2007) for discussion on this topic).

The assumption of independence of alternatives (IIA) is violated in our case (ChiSqrd=22.49, Pr(C>c) = 0.021). For overcoming the limitation of the MNL a random parameter logit (RPL) model is used for allowing preference heterogeneity (McFadden and Train, 2000). The RPL model estimated here (

Table **4**) examines the effect of the attributes on choice behaviour by including the improvement in the water quality to the very good level in the different zones that add up to the whole river basin. Attributes are thus included as dummy variables for each of the possible water quality improvements (e.g. zone Alto from good in the baseline situation to very good level of water quality; zone Valle from moderate in the baseline situation to good and very good level of water quality, etc.). WE allow for the randomness of the attributes parameters. The chosen distribution of the random terms is the uniform distribution, as recommended by Hensher *et al*. (2005) for dummy variables[8]. The RPL models are estimated using 500 Halton draws (Bhat, 2001). The cost or 'price' attribute of the alternatives is also modelled in order to obtain the Hicksian welfare measures. Household income is also included as explanatory variable.

Spatial heterogeneity of preferences is accounted for by interacting the attributes with dummy variables identifying the zone of residence (e.g. variable "resident of zone Alto" taking value 1 when the person lives in zone Alto and value zero otherwise)[9].

All attributes are significant with expected signs (expect for Doñana improving to the good level of water quality). This means that the public derives significant positive benefits from the improvement of water quality, except for the zone Doñana where the improvement is only valued if it is for reaching the high ecological status (very good level). As expected, the more expensive the proposed improvement, the least utility is derived (cost attribute resulting negative and significant); as well as individuals with higher income are WTP more for the environmental change (as theoretically expected).

It can be observed that the interactions are only significant when the attribute and the zone of residence coincide, this is when the ecological status improvement takes place in the zone of residence (eg.'Valle Very Good * Resident of Valle'; 'Campiña Very Good * Resident of Campiña'). The rest of the interaction variables (e.g. "Valle Very Good" * "Resident of Campiña") are not significant. This implies that the public derives an extra value when the improvement of the water quality takes place in their zone of residence. Accounting for this extra value of local residents is necessary for more accurate welfare estimations.

INSERT TABLE 4 HERE

[8] Other distributions, such as the normal, were also tested producing similar results.
[9] Only the interactions between zone of residence and improvement of water quality to the very good level are included (not the moderate and good level), as they proved to be not significant.

The model presents a good fit according to the McFadden’s R-square criterion (R-square above 20%) (Hensher and Johnson, 1981). The standard deviations of the random terms have proved to be significant in most cases.

Transferability of compensating surplus measures

WTP values for the improvement of the water quality in the whole Guadalquivir river basin for the inhabitants of the different sub-basins are presented in Table 5. Standard errors for the MWTP values are calculated using the Delta method (e.g. Greene, 2003).

WTP values for the improvement of the Guadalquivir River basin to the good ecological status vary between €165 per year and household for the inhabitants of Alto, to €193 for the inhabitants of the Campiña area. These differences show that the environmental benefits are not equally distributed across the inhabitants of the different areas of the river basin due to the differences in the status quo in the different areas (Alto is the zone with a higher baseline water quality level –good- and Campiña is the one with lower level –bad-) and the extra value of the local residents for the improvement of the water quality in their area of residence.

We have observed that the relationship between the place of residence and the value given to the improvement of water quality occurs is similar across sites (significant for the local residents and non-significant for the non-local residents). We expect that controlling for this as a core characteristic of the policy and study site, produces low transfer errors.

Table 6 shows the resulting transfer errors, which range from 1.43% from zone Valle to zone Campiña, to 18.26% from zone Alto to zone Valle. The average transfer error across all the areas is of 11.3%.

INSERT TABLE 5 HERE

INSERT TABLE 6 HERE

The resulting transfer errors can be considered as moderate errors in comparison with what has been estimated in the literature (see Table 1), being below the 20% criteria chose by Kristofersson and Navrud (2005). Morrison *et al*. (2002) obtained transfer errors between 4 and 191%, Rozan (2004) observed errors of around 25%, Colombo *et al*. (2007) measured an average transfer error of 66%, and Colombo and Hanley (2008) obtained a range of errors is 15-95% for benefit function transfers, and 1141-2234% for direct transfer. Additionally, from a meta-analysis of rivers and wetlands Brouwer (2009) finds that the transfer error obtained from the meta-model of choice experiment studies is always higher than 40%.

6. Conclusions

The WFD is a major regulatory reform of water resources management in which integrated management plans must be prepared for river basins in order to achieve 'good ecological status' in all European waters. Given the Directive's ecological focus, non-market benefits are expected to make up a large share of the total economic value of WFD implementation. The WFD furthermore offers the opportunity to lower water quality objectives for all water bodies or delay their realization in time based on the concept of disproportionate costs. For this, a comparison of the expected costs and benefits and their distribution across water bodies and water quality levels is needed.

Given the lack of comparable benefit estimates for European river basins and the tight time schedule imposed by the WFD on European Member States, benefits transfer is expected to be among the most important valuation methods to estimate benefit-cost ratios for the identification of disproportionate costs. However, the literature is still debating on the validity of transferability techniques and what similarity criteria between study and policy site produce acceptable transfer errors. Policy-makers are likely to be constraint by budget when estimating the non-market benefits of the WFD and may find themselves obliged to transfer values elicited from the inhabitants of a pilot area to the whole catchment. The acknowledgement of the errors associated with this transfer is of high policy relevance in order to determine the reliability of the economic estimates.

Here we have presented a novel approach accounting for spatial heterogeneity of preferences, in which respondents living in different parts of the river basin are asked to value water quality changes simultaneously across different parts of the basin. This is expected to be particularly relevant for the implementation of the WFD where baseline conditions and the population of beneficiaries vary across European river basins. Based on the results of a choice experiment, we calculate transfer errors for the whole river basin across the inhabitants of different sub-basins. These transfer errors are on average 11.3%, which can be considered to be low, according to what is shown in the literature. This result is encouraging for the potential policy applications of benefit transfer, where accounting for spatial characteristics such as the place of residence of beneficiaries can give us more accurate values for the policy sites.

We conclude that environmental change and its related welfare changes on the population cannot be considered isolated from the territory in which the change takes place. Valuation literature is giving increasing attention to the spatial representation of the estimation of monetary values, and benefit transfer can benefit from this. Transfer procedures should be focused on the core characteristic of the sites under valuation, among which the spatial dimension should be considered. Future improvements should be on enlarging the scope of this exercise and comparing transfer errors between river-basins when considering beneficiaries attachment to land or territory.

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Table 1. Transfer errors in water valuation studies

Study	Resource valued	Methodology study site	Transfer error (%)
Parson and Kealy (1994)	Water recreation	TC	4-34
Bergland *et al*. (1995)	Water quality	CV	25-45
Morrison and Bennett (2000)	Wetlands	CE	4-191
Van der Berg *et al*. (2001)	Groundwater quality	CV	1-239

Colombo *et al.* (2007)	Soil erosion	CE	66
Loomis (1992)	Sport fishing	TC	5-40

Source: adapted from Brouwer (2000) and Rosenberger and Stanley (2006).

Table 2.Choice experiment attributes and levels

Attributes	Baseline	Levels
Water quality improvement in zone Alto	Good	Very good
Water quality improvement in zone Valle	Moderate	Good Very Good
Water quality improvement in zone Campiña	Bad	Moderate Good Very Good
Water quality improvement in zone Doñana	Moderate	Good Very Good

Table 3 Sample and population characteristics

Characteristic	**Sample**	**River basin population**[1]
Gender distribution (% women)	54.7	51.4
Age distribution (%)		
18-34 years	34.1	32.5
35-59 years	44.6	48.8
> 60 years	21.3	18.7
Average household size (people)	3.3	2.8
Share households with children (%)	66.2	63.8
Average disposable household income (€/month)	1,940	1,619
Education distribution (%)		
No finished education level	15.3	17.1
Primary and secondary school	64.0	69.9
Higher education level (university)	20.0	13.0
Overall percentage unemployed	5.5	11.0
Percentage employed in agriculture	6.9	9.4

[1] Source: Regional Institute for Statistics (http://www.juntadeandalucia.es/institutodeestadistica/). Data for the region Andalucía, where 90 percent of the river basin population is found.

Table 4. RPL Model

Variable	Coef.	S.E.
Attributes		
ASC	-0.375	0.390
Alto Very Good (AVG)	0.521*	0.307
Valle Good (VG)	1.419***	0.441
Valle Very Good (VVG)	1.502***	0.489
Campiña Moderate (CM)	1.588***	0.439
Campiña Good (CG)	1.983***	0.539
Campiña Very Good (CVG)	2.140***	0.584
Doñana Good (DG)	0.365	0.248
Doñana Very Good (DVG)	0.381*	0.239
Interaction with zone of residence		
AVG * Resident of Valle	-0.363	0.322
AVG * Resident of Campiña	-0.148	0.429
VVG * Resident of Valle	0.800*	0.451
VVG * Resident of Campiña	-0.083	0.482
CVG * Resident of Valle	0.667	0.464
CVG * Resident of Campiña	0.923*	0.574
Economic variables		
Household income	$0.590*10^{-3}$***	$0.206*10^{-3}$
Cost price	-0.033***	0.008
Standard deviations		
AVG	3.482**	1.267
VG	0.136	1.148
VVG	3.401**	1.338
CM	0.154	1.793
CG	2.825*	1.709
CVG	3.446**	1.639
DG	3.271**	1.381
DVG	3.414**	1.435
Model summary		
Log likelihood	-1551.241	
Adjusted R^2	0.226	
N	1412	

Table 5 WTP mean values of the improvement of the whole river basin by inhabitants of different areas

Mean WTP values of the whole River Basin (€ per year and household)		Std. Error
Values given by residents of Alto	165.64	15.84
Value given by residents of Valle	195.89	18.57
Value given by residents of Campiña	193.08	26.13

Table 6 Transfer errors of the value of the whole river basin across inhabitants of different sub-basins

Zone transfer error					
A → V	V → A	A → C	C → A	V → C	C → V
-18.26%	15.44%	-16.57%	14.21%	1.43%	-1.46%

A→V should then be interpreted as follows according to the specifications of equation (4): A = WTP_i and V = WTP_j, where A refers to the estimated WTP value for the whole RB by residents of Alto, V for residents of Valle, and C for residents of Campiña.

Figure 1: Current water quality levels in the Guadalquivir river basin

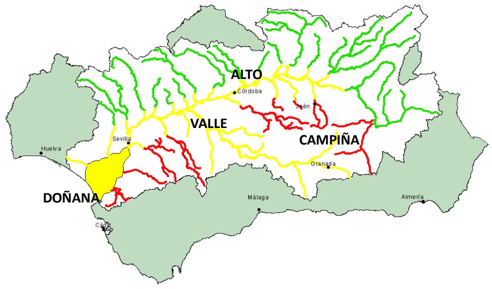
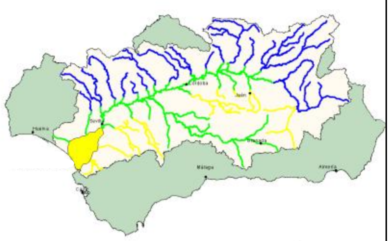
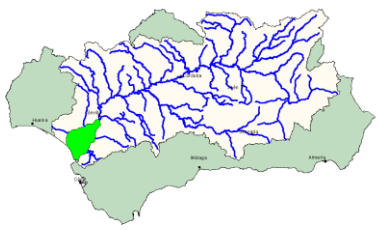
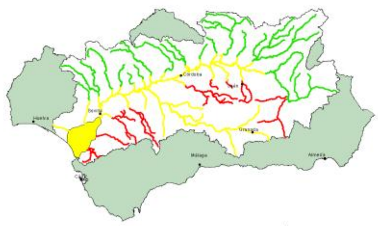
<table>
<tr><th>Current Water Quality levels</th><th colspan="2">Water Quality Ladder</th></tr>
<tr><td rowspan="4">
</td><td>Very Good</td><td>Suitable for drinking; high ecological status of the water environment</td></tr>
<tr><td>Good</td><td>Suitable for recreation like swimming and fishing</td></tr>
<tr><td>Moderate</td><td>Suitable for sprinkling gardens and irrigation</td></tr>
<tr><td>Poor</td><td>Not suitable for any of the above uses</td></tr>
</table>

Figure 2: Example of a choice card

SITUATION A	SITUATION B	CURRENT SITUATION
		
€50 PER YEAR	€150 PER YEAR	NO INCREASE IN WATER BILL