Using the choice experiment method for valuing improvements in water quality: a simultaneous application to four recreation sites of a river basin*

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Abstract

Using the choice experiment method, this paper examined local residents' preferences for water quality management at a specific river basin in France, in the context of the Water Framework Directive. The study design accounted for improvements in water quality resulting from the measures described in the river basin management plan. Site-specific attributes were defined, which included the four sites that compose our water body. Each attribute was assigned two levels: one corresponding to the current situation and the other to the improvement situation. These attributes levels were combined to result in different management options, each associated with a 'monetary price'. Respondents were asked to choose their preferred alternative in the choice sets, each consisting of three water management options for the four sites (more precisely, two improvement options and the 'status quo' option). Then we estimated the value of water quality improvement at each site. Our estimation strategy consisted in estimating first, a conditional logit model and then, a random parameters logit model in order to take into account heterogeneity of preferences. Results show that people are willing to pay for improvements in water quality. However, we find that total benefits accruing from such improvements are not sufficient to cover costs of measures. We finally show that protest bids do affect the results.

Keywords: Water quality; Water Framework Directive; Recreation; Choice experiments; Zero bids

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1 Introduction

The European Water Framework Directive (WFD) of October 2000 (2000/60) has established a Community framework for water protection and management policy at the European Union level. The Directive gives priority to environmental protection. It provides, among other things, for the achievement of 'good ecological status[1]' in all European waters by 2015. For this purpose, it expects the adoption of management plans and programs of measures prepared for all river basins and appropriate for each body of water[2]. Each country member of the European Union thus has to adopt management regimes to reach the objective. However, the Directive provides time extensions if the costs necessary to undertake the restoration measures outweigh the benefits. Therefore, the Directive gives a prominent role to economic approaches in its implementation, since cost-benefits analysis can contribute to an assessment of whether costs of measures may be considered as disproportional. Monetary estimates of the benefits of improved water quality could be used in this context as an indicator for disproportionality. While water experts have proven techniques to compute the costs, it is much more difficult to weigh up the benefits that people will get from an improvement in water quality. The development of methods for valuing the environment has enabled the examination of individuals' preferences for environmental goods. In the literature there are a large number of studies that value water quality on a particular recreation site. Some of them are based on surplus measurement through data about transportation costs that people incur when visiting the site from some distance away (Appéré et al., 2003[2], Cooper et al., 1993[7], Mendelsohn et al., 1992[19]). Other involve contingent valuation techniques that enable the examination of water quality preferences from individuals, through the estimation of their willingness to pay (WTP) for a specific improvement program (Bonnieux et al., 1993[4], Carson et al., 1993[6], Kosz, 1996[12]). This kind of studies enable to examine goods that provide non-use values (that is to say existence value or heritage value like altruism and bequest motives). More specifically, the recent progresses of the Choice Experiment method has made possible multi-attribute valuation of environmental goods as defined by their characteristics (or attributes). There are fewer applications that have been interested in water quality valuation on a single recreation site. They describe the attributes of the site in terms of allowed recreation activities (fishing, swimming, water activities like windsurfing for example), survivability of fishes or other organisms, evidence of food and habitat for wildlife (for example existence of land and/or aquatic biodiversity, habitat preservation), drinking water quality, etc. (e.g., Hanley et al., 2006[9], Blamey et al., 1999[3]). There are even less

[1] A good ecological status includes a set of qualitative norms, including not only biological and chemical measures but also social measures for water use, that have to be satisfied. For example, this could be the morphological status of the banks of a river or the number of species which lives in that river or the possibility for drinking water.

[2] Water body types include rivers, lakes, reservoirs, transitional waters and coastal waters.

applications that have examined the spatial dimension in goods that provide both use and non-use values for the sites or for the attributes of the sites (Horne et al., 2005[11], Farber et al., 2000[8]).

In this study, we focus on a multi-attribute valuation for the case of water quality management in a system of several recreation sites in Normandy (France). We use site-specific attributes in order to capture a different kind of information than with classical Choice Experiment (CE) studies. Indeed we do not focus on individual's preferences for the type of water resources' management (ie for the specificities of the management regime) but rather on people's preferences for the distribution of management efforts in a complex of sites that are somehow interrelated, according to their considerations for each site. Taking into account spatial dimension is of particular interest for us because we aim at valuing the benefits for a specific body of water in its whole in the context of the WFD.

Therefore the environmental good we study is a river basin located in Lower-Normandy (France). It consists of three watersheds (the rivers Dives, Touques and Vie) and coastal waters (the coastline of 'la côte fleurie' between the seaside resorts of Merville and Trouville sur Mer). Thus we define those four sites as recreative site-specific attributes.

Water resources in Normandy face a variety of demands including preservation of natural heritage (i.e. the scenery of the site like riverbanks, meadows, etc.) and biodiversity (including emblematic species such as the sea trout), recreational use (swimming, fishing, shellfish harvesting, hiking, etc.), drinking water supply (through the improvement of groundwater quality) and prevention of flood risks (in controlling surface water and groundwater flow) which are of major interest. Those demands each require a set of features from the water environment. There are different levels of requirements for those features; it is therefore necessary to design a management regime in order to achieve a particular ecological status. The latter has to fulfil both the requirements of the WFD and the needs of the area residents. Since the individuals who live in a neighborhood of our river basin of interest are directly or indirectly affected by its status, we need some information on their preferences in order to compute the benefits that would be induced by an improvement in water quality.

The aim of this study was to value residents' preferences for simultaneous water resources management regimes at the four recreation sites defined above. So, we first examined the tradeoffs (ie, the choices) between these different management programs (each combining elements of water management at each of the study sites). One main focus in this study was therefore on the values people place on improvements in these recreation sites, and thus on the non-market economic benefits of moving towards good ecological status. Heterogeneity of people's preferences was taken into account in the analysis. Notice that preferences for water management at one site might be somewhat different than preferences for water management over the four sites in the study area. Thus, the study area could be viewed as a system of spatial units where the management regime could consist of different levels of management intensity among the sites, depending on the objective (of improvement in water quality) that is assigned to each site. Hence, treating the study area as a system of four recreation sites enabled to take into account multidimensional changes in the management of water quality, and thus to capture preferences for spatial variability in the characteristics of the environment that result from different management practices. However, we were also interested in the way individuals state their preferences. Indeed, a significant proportion of individuals usually choose not to report their 'real' value for the good. Therefore we wondered if such behaviors could bias the results. Accordingly, we secondly restricted our analysis to only individuals who stated their 'real' value, to see if these estimates differed from those obtained when conducting the analysis on the entire sample of residents.

The first result of the study was that people not only value the sites, but are also prepared to pay for water quality improvements. Therefore we found that people place positive significant values on each of the four sites for which improvement measures were described in the survey. Moreover we found that the probability of choosing an improvement management program increases with respondent's income. It is worth noting that people incur some disutility when moving from the current situation, which is nevertheless more than compensated by the utility they get from a situation where water quality is improved. This is as if people bear a 'cost' when they accept to move from the current situation, but which is lower than the benefit they get from the improvement situation. Therefore, despite of this 'cost', the willingness-to-pay for water quality improvements (that is to say the amount people are prepared to pay for such an improvement) are positive. Thus, we obtained a willingness-to-pay for a water quality improvement at the entire river basin equals to about 52.1 € per household and per year.

Evaluating people's preferences for water management regimes enables to measure the non-market benefits that would arise from an improvement in the quality of water. Therefore, in the particular context of the WFD, it was made possible to compare the costs and benefits induced by the achievement of a good ecological status in the study area waters. We found that costs strongly outweigh benefits, so that costs can be considered as disproportional.

Another major result of the paper was that restriction of the analysis to only 'real bids' does change model estimates. Exclusion of 'false bids' from the analysis was made possible because both samples ('real bids' and 'false bids') were not self-selected. Thus, the implicit prices (ie., the willingness-to-pay) we got are affected by the presence of 'false bids' in the sample.

In what follows, Section 2 describes the Choice Experiment method of environmental valuation and depicts the survey design and the data used for our case study. Section 3 explains the statistical methodology, whilst Section 4 presents and discusses the results. Finally Section 5 concludes.

2 Methods and data

2.1 The Choice Experiment method

The Choice Experiment method is a variant of Conjoint Analysis. This latter was first used in marketing to value consumers' preferences for consumption products, and was then derived and suited to be used as an instrument for environmental valuation (Louviere and Hensher, 1982[14]; Louviere and Woodworth, 1983[16]). Choice experiments are one possible form of conjoint analysis. They are based on stated preferences since they elicit information concerning environmental preferences from individuals through the construction of a hypothetical, but realistic, market involving an improvement or a decline in environmental quality, rather than on revealed preferences which can be derived from real actual behavior. We apply CE to estimate the value of improvements in water quality. In Choice Experiments, respondents are presented with a number of choice sets consisting of a menu of alternatives (also called scenarios) relative to environmental policy options. They are asked to choose their preferred alternative from each of these choice sets. In order to construct them, the study good is decomposed according to its attributes (or characteristics), and the combination of various levels of this set of attributes results in a scenario of change in environmental quality, also called an alternative. The levels of the attributes are influenced by the chosen water management strategy (ie, in our study, by the objective of good ecological status). One of the main advantages of the Choice Experiment approach is that attributes can be qualitative or quantitative in nature, and that the method allows to combine attributes of different nature when we construct a scenario. Notice that a baseline scenario, the status quo, is very often introduced as an alternative in the choice sets; this enables the respondent to choose no change (ie, to keep the current management situation). Because we desire to estimate a value for each of the site-specific attributes rather than values for management regimes in their whole, the decision to use a CE approach, instead of a Contingent Valuation approach, is well justified. Whereas the Contingent Valuation method produces a single value for an overall change in environmental quality, Choice Experiments provide a value for each individual attribute of an environmental program. Hence, alternatives are such that preferences for various attributes can be examined at a more refined level.

2.2 Study area and data collection

Our choice experiment study was motivated by the need to value the non-market benefits induced by water quality improvement in the context of the European Water Framework Directive. Up to now, all French valuation studies were interested in estimating non-market benefits associated with improvements to the ecology of a single water site (eg., a river stretch or a groundwater). However, actions which aim at restoring aquatic environments are not covered by specific initiatives. Indeed, a local modification in water quality has some impacts on the quality of the surrounding watersheds and water bodies. Thus, when designing this study, we decided not to study a classical environmental good of interest (a specific river for example) like previous reference studies of river ecology changes do, but to broaden it to an area that will also include at least one of its watersheds. In this context, we chose to consider a river basin composed of a coastal strip[3] and its catchments. After some discussion with officers from French Water Agencies, the study area was located in Lower Normandy and consisted of the four outdoor recreation sites of 'la Côte Fleurie', 'la Touques', 'la Dives' and 'la Vie'. This area lies down on three counties: 'Calvados', 'Orne' and 'Eure'. The Rivers Touques, Dives and Vie are the three watersheds of the coastline of 'La Côte Fleurie' (see Figure 1 for a map of the study area). Those four sites are frequented primarily for water-based recreation (walking, hiking, fishing, swimming, canoeing, etc.). Thus, an improvement in the quality of waters could increase users', but also non-users', welfare (non users giving value to the site because others are, or will, be able to use it, or just because it exists, independently of any possible use). The management and the maintenance of these waters are ensured by the municipalities through which they pass and to which they belong. Those sites were chosen because their ecological status are heterogeneous and, as a consequence, management plans that have to be designed differs a lot.

'La Côte Fleurie' is a well-known coastal area along the Channel Sea that goes from the city of Trouville-sur-Mer (located between the cities of Deauville and Honfleur) to the one of Merville-Franceville (situated next to the city of Cabourg). It is currently in a 'bad[4] status' (note that it is graded 3 on the French Environment Ministry's General water planning and management scheme[5]) because of the problems listed hereafter. There is a proliferation of algae, which has noxious consequences in terms of health on the shellfish quality. Furthermore, some sewage and litter discharge into the sea, nearby coastal towns, when the weather is rainy. This phenomenon is due to mass urbanization of the coastal area, and results in a deterioration of swimming waters quality (notice that swimming waters are of middle quality when the weather is fine). Thus, swimming and shellfish gathering are sometimes forbidden after summer thunderstorms that occurs, in average, two or three times a year; shellfish gathering is always forbidden at the East of Trouville. In order to achieve a good ecological status in coastal waters, management plans include a control of algal growth and a joint policy of sewage treatment and litter cleaning.

The River Touques extends from Gacé in the Orne county to the Channel Sea (it empties into the Channel sea between the cities of Deauville and Trouville). It is very famous because it is the French river that contains the largest number of sea trouts. Notice that we con-

[3]This study is someway a pioneer one since, to our knowledge, no French study has focused on ecology changes in coastal waters.

[4]The levels of quality can be classified on a semantic scale as follows: bad $<$ poor $<$ moderate $<$ good.

[5]This scheme is called 'SDAGE' in French; it gives a grade to each catchment, which is between 1 to 5 (where 1 refers to 'good status' and 5 to 'bad status').

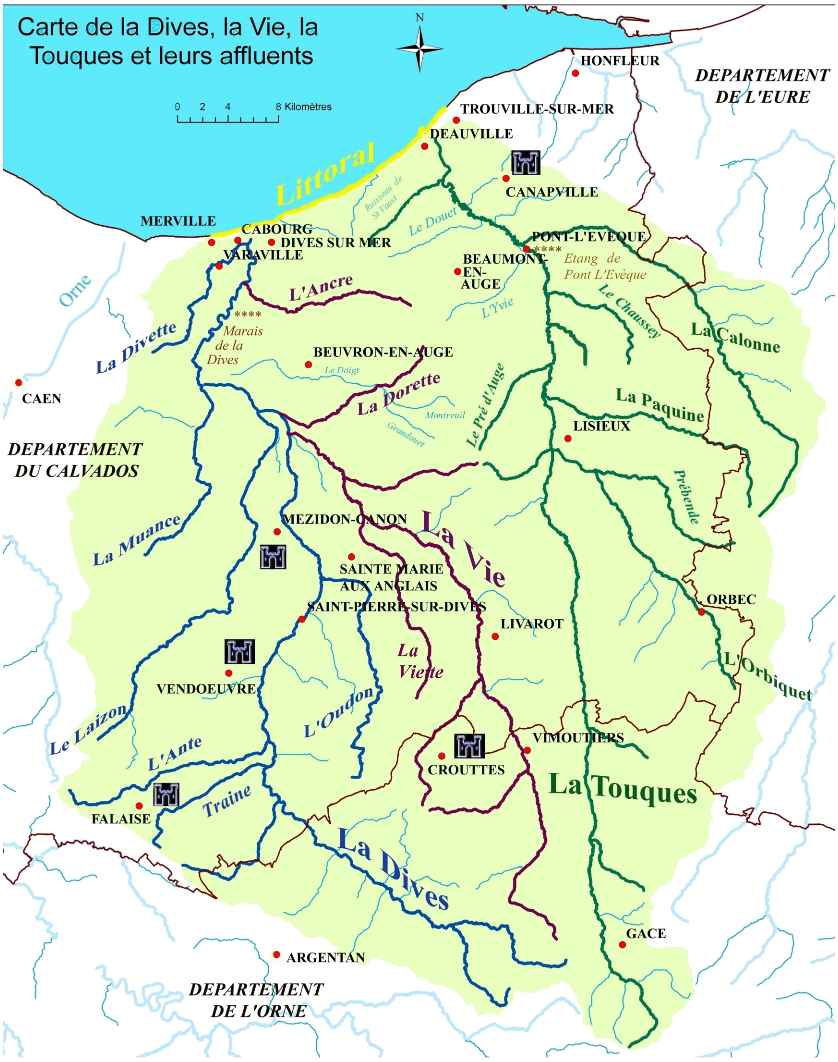

Figure 1: Map of the river basin

sider that its tributaries (the Rivers 'Orbiquet' and 'Paquine' inter alia) belongs to the River Touques catchment. The latter is currently in a moderate status (graded 2.3 on the French Environment Ministry's General water planning and management scheme). Inside the river, existing problems include the presence of dams that are not properly constructed, so that they make the movement of migratory fish difficult. Problems also exist with the proliferation of fertilizers-intensive crops on the river banks that results in the pollution of groundwater that supplies the area with drinking water. There are also mudflows during heavy rainfalls. In order to achieve a good ecological status in the River Touques, management plans encourage the presence of grasslands rather than crops on the river banks. They also sustain the work that has already been initiated and that involves removing dams, or developing them by building fishways. That way, preservation of natural heritage and emblematic species like sea trouts will be ensured.

The River Dives also rises in Gacé but, conversely to the River Touques, it empties into the Channel sea near the city of Merville. We consider that its tributaries (the Rivers 'Divette' and 'Ante' inter alia) belongs to the catchment. The River Dives is surrounded by broad plains of cereal crops and characterized by emblematic sites as 'the Dives marsh' for example. It is currently in a bad status (graded 3.5 on the French Environment Ministry's General water planning and management scheme). The river is heavily polluted by agriculture and animal husbandry. Indeed, fertilizers, pesticides and livestock manure pollute water, which may have toxic effects on human health. Moreover, increased erosion of the soils, which results in mudflows and inundations in case of heavy rains, is a consequence of the loss of bankside vegetation, and of animals' trampling when they come and drink in the river. In order to achieve a good ecological status in the River Dives, restoration plans involve good agricultural practices. Furthermore, landscaping of the river banks (eg., planting of grass strips and hedges) will be provided in order not only to slow down waters flow but also to recover and support habitat and associated fish and wildlife populations.

The Rivers 'Vie', 'Ancre' and 'Dorette' are the eastern tributaries of the river Dives. We chose to consider that they were not part of the Dives catchment because their waters were not in the same ecological status as the one of Dives. Thus, for the needs of the study, we consider that they form a separate watershed that we call 'the River Vie'. This watershed rises in Gacé and empties into the River Dives near the city of Cléville. It is located in the area of 'Pays d' Auge' and is made of grasslands and groves where traditional animal husbandry is practiced. The River Vie is currently in a poor status (graded 2.7 on the French Environment Ministry's General water planning and management scheme) and several phenomena are responsible for it. As the Dives, banksides are damaged because of the cows' trampling, and intensive crops results in water pollution. Moreover, man-made structures build in the riverbed have impacts on the way the river functions; in particular it hinders migration of fish upstream. In order to achieve a good ecological status in the River Vie, appropriated measures enable the restoration of riverbanks and the preservation of grasslands thanks to the control of agriculture practices. The construction of fishways will encourage migratory fishery.

Sampling of the population to study was undertaken as follows. First a scope of influence for the study area, which corresponds to the area from where residents who are used to visit the sites come, was chosen. It was determined thanks to discussions with officers of the local Seine-Normandy Water Agencies, and it was decided that it would cover a radius of 15 kilometers around each of the three rivers and a distance of 80 kilometers from the coastline[6] (which corresponds to a maximum of an hour's drive). Then it was decided to survey a representative sample of the inhabitants of this scope of influence. Thus a quota-sampling approach was used, which had to ensure that the sample reflected some socioeconomic characteristics (age and occupation of the head of family, number of persons in the household,

[6]Residents' fascination for the coastline is much more stronger than the one for the recreation rivers.

and population of the cities located in the definite scope of influence) of resident households (that is, households who live in the study area)[7]. Thus, a sample of 880 resident households was surveyed[8] using in-house interviews[9] by trained pollsters working for a French Custom Market Research specialist in the summer of 2008. This sample is quite large compared to other studies reported in the introduction (eg, Hanley et al., 2006; Horne et al., 2005). Choice experiments surveys are usually conducted in-house or on site by interviewers, in order to make the choice exercise simpler to the respondent. Indeed, this type of survey could be difficult to understand; so the pollster is here to explain the task to the respondent and to answer her questions if the latter encounters some difficulties. It does not matter whether respondents have ever visited the recreation sites of interest once in their life. Prior to data[10] collection, the questionnaire was tested with a few residents in order to check that it was well designed, and also to gauge reaction to the idea of the need to pay for improvements in water quality.

2.3 Survey design

The good we want to value in the context of the Water Framework Directive is the quality of water in a definite water body. Because ecological status in waters was not the same at all parts of this water body, specific management plans had to be designed for each of these parts. Hence, our procedure amounts to considering a global system consisting of four distinct spatial units, and giving them a role of spatial attributes, which can be described as site-specific attributes. Therefore, we chose four site-specific attributes for our CE study. The latter were the sites defined in Section 2.2. Each attribute was set at one of two levels. The 'status quo' level was set out in such a way as present management situation would be maintained on the site; thus, it was described as to be consistent with current conditions on the site. The 'good' level corresponded to good ecological status in water quality expected under the WFD; it was presented in such a way as to describe the conditions that would likely result from the implementation of the management plan.

A monetary attribute is also needed in order to estimate implicit prices for each level of the site-specific attributes. The corresponding payment mechanism was established as an annual voluntary contribution, paid by households, to an organization that would be put in charge of the restoration work. We designed four possible levels for the price level, which were chosen based on previous contingent valuation studies of river ecology improvements

[7]The fraction of each characteristics class in the sample have to be proportional to its share of the resident population. This is required in order to prevent from selection bias.

[8]More precisely, we collected 220 responses in the scope of influence of each of the four recreation sites.

[9]The choice of in-house interviews rather than on-site interviews was motivated by the will to survey residents. Moreover, on-site sampling might generate selection bias.

[10]Data used in this survey belongs to the French Environment Ministry (*MEEDDM - Commissariat Général au Développement Durable*)

Attribute	Option A	Option B	Status quo option
Coastline	Current bad status	Good status	Current bad status
River Touques	Current moderate status	Good status	Current moderate status
River Dives	Good status	Current bad status	Current bad status
River Vie	Current poor status	Good status	Current poor status
Annual contribution	10 €	30 €	0 €

Figure 2: A simplified example of a choice set used in the choice experiment survey

in France. Thus the price vector was 10 €, 20 €, 30 €, 40 €. Notice that a null level was associated to the 'status quo' scenario; it is not included in the price vector because a 0 € price (namely pay nothing) does not seem realistic in the case of a water quality improvement. We observe that numbers of levels for each attribute are pairwise multiple. This constitutes a methodological recommendation for CE because it enables to provide a balanced design as choice sets are constructed.

Attributes and levels were then assigned into choice sets. We chose to construct choice sets each consisting of three alternative water management regimes for the four sites. Two of them were improvement alternatives (or scenarios), and the third one was always the so-called status quo that referred to the current management regime. The attributes and levels resulted in ($2^4 \times 4^1$) different combinations[11], that is to say 64 choice sets. Since this number of alternatives is very large, a fractional factorial design was use to minimize the number of choice combinations presented to respondents (Louviere et al., 2000[15]). Given the number of attributes and their levels, 8 choice sets are produced. Since the number of choice sets presented to each respondent should not exceed her cognitive capacity (Swait et al., 2001[21]), 8 choice sets did not seem reasonable. Hence they were blocked (that is, disaggregated into manageable groups) in 2 versions of the CE, each containing 4 choice sets. Thus, each respondent was asked to answer 4 choice questions. Each of them consisted of three options among which she was instructed to choose her preferred one: option A and option B, which gave an improvement in at least one site-specific attribute for a positive price, and a status quo option resulting in zero-improvement for a zero-price (see Figure 2 for an example of a choice set).

Because each site-specific attribute has only two levels, options A and B can be thought of as representing the outcomes of alternative waters management plans for each recreation site, with their associated costs; therefore, the choice of option A (or similarly of option B) can be regarded as giving support to the management plan associated with it. Each choice question is presented using a choice card which consists of the three available options (option A, option B and status quo option), and of information about the attribute levels in each

[11]Because the status quo alternative is the same in all the choice sets, it is not generated by the way of the experimental design.

option. Prior to answering the choice tasks, the respondents were given written information on the attributes used in the CE. They were explained the current ecological status and the present management practises at the sites, and information on the payment mechanism was given. The same information was given to all respondents.

The survey instrument also contained other sections preceding the choice experiment section[12]. First, there was some questions about the socioeconomic characteristics of the respondent. Then the respondent was asked about her attitudes towards the four recreation sites, water management of these sites and environment in general. Eventually the respondent was presented the choice questions. When the respondent systematically chose the status quo option, irrespective of the choice set, she was asked an ancillary question in order to know the reason underlying her choice behavior. This enabled to categorize the systematic zero bids into two types: 'true zeros' and 'false zeros'. These notions will be detailed further in Section 3.7. In order to prevent, or at least to limit, respondents from refusing to make a choice, or hypothetical bias (ie., the consequence of the respondent overestimating her real WTP), or still protest behaviors (eg., respondents who systematically chose the status quo option because they considered it was not their duty to pay for waters management of the sites), interviewers were advised not to highlight the price attribute more than other attributes when describing them. Indeed the idea was that respondents took into account overall alternatives when choosing their preferred one rather than only focusing on their associated cost.

3 Statistical methodology

3.1 General remarks about multinomial models

The Choice Experiment method is based on the new approach to consumer theory (Lancaster, 1966[13]). This characteristics theory of value states that "a good, per se, does not give utility to the consumer; its possesses characteristics, and these characteristics give rise to utility". Moreover, the CE method is consistent with random utility theory (Marschak, 1960[17]). Thus, because individuals are assumed to choose the alternative which maximizes their utility, we can apply probabilistic models to choices between the different alternatives available in each choice set; therefore a good is valued in terms of its attributes. We always introduce an attribute which takes the form of a price (actually it is a proxy for price or a cost term, such that a household tax or voluntary contribution for example) and, thus, willingness to pay estimates for changes in attributes levels can be derived from marginal utility estimates.

In this study, we want to model unordered multinomial outcomes that arise from individual choices. Random utility theory describes the indirect utility of an alternative (U) as

[12] A copy of the questionnaire can be asked to the corresponding author.

the sum of a deterministic and a stochastic components. The deterministic component (V) is a vector of observable alternative (and sometimes individual) specific attributes. It usually takes the form of a linear index of those attributes. The stochastic component (ε) stands for all the influences affecting the choice that are not observable by the researcher. It is an error term that comes from the fact that the choice is random from the researcher's viewpoint.

The underlying indirect utility function that individual 'i' gets when he chooses alternative 'j' is of the form:

$$U_{ij} = U(X_j, P_j, \varepsilon_{ij}) \tag{1}$$

where: 'X_j' is a vector of attributes describing alternative 'j' and 'P_j' is the monetary cost (or price) associated with alternative 'j'. The indirect utility function may be partitioned into two components, so it can be rewritten as follows:

$$U_{ij} = V_j + \varepsilon_{ij} = V(X_j, P_j) + \varepsilon_{ij} \tag{2}$$

where V_j is the observable part of the indirect utility function that individual 'i' gets when he chooses 'j' and ε_{ij} the random (unobservable) part of this function. According to random utility theory, individual 'i' will choose alternative 'j' from the choice set t if the indirect utility of 'i' is greater than that of any other choice 'k'. Thus, individual 'i' will choose alternative 'j' over alternative 'k' if and only if:

$$U_{ij} > U_{ik} \Rightarrow V_j + \varepsilon_{ij} > V_k + \varepsilon_{ik}, \forall k \neq j; j, k \in t, \tag{3}$$

where U_{ik} is the value taken by the indirect utility when individual 'i' gets when he chooses alternative 'k'. This means that individual 'i' prefers alternative 'j' to any other alternative 'k', that is the satisfaction received from choosing 'j' exceeds that received from 'k'. We observe the outcome $y_i = j$ if the utility got from the choice of j is greater than the one got from any other alternative of the choice set t. Therefore, the probability of individual 'i' choosing alternative 'j' over alternative 'k' can be expressed in terms of utility (that is in terms of the observable and error parts of the utility function) and is such that:

$$\begin{aligned} P(y_i = j|t) &= P(U_{ij} > U_{ik}), \forall k \neq j; j, k \in t \\ &= P(V_j + \varepsilon_{ij} > V_k + \varepsilon_{ik}), \forall k \neq j; j, k \in t \\ &= P(\varepsilon_{ik} - \varepsilon_{ij} < V_j - V_k), \forall k \neq j; j, k \in t. \end{aligned} \tag{4}$$

That is, this corresponds to the probability that the utility got from the choice of 'i' is greater than the one got from any other alternative of the choice set t.

In order to make the latter equation empirically efficient, we make some assumptions both on the distribution of the error terms and on the functional form of the V's (in order to obtain econometric models that could be easily estimable). When analyzing multi-attributes choices, the probability of an alternative being chosen as the most preferred (among a definite set of alternatives) is commonly expressed on terms of the logistic distribution, which results in the 'conditional logit model' specification[13] (McFadden, 1973[18]). In this context, the common assumption is that the error terms of the indirect utility function are independently and identically Gumbel-distributed (ie., the ε's are IID with an extreme-value distribution). Thus, individuals' choices are based on utility differences between the scenarios of the choice set, and the error components enable to obtain information, in terms of probability, about individuals' behavior when they face multi-attribute choices. This implies that the probability of individual 'i' choosing 'j', given the characteristics X_j and P_j, is:

$$P(y_i = j|t) = \frac{\exp(V_j)}{\sum_{h \in t} \exp(V_h)}. \tag{5}$$

Regarding the observable part of the indirect utility function, $V(.)$, we assume that it is linear in its arguments.

Some descriptive analysis told us that nearly a third of the respondents systematically chose the status quo. Hence, it seemed relevant to take into account the 'status quo effect'. We thus introduced alternative specific constants (ASC), which are dummy variables that equal one when the alternative in question was chosen. This choice was guided by the fact that such a constant enabled to capture the effects of non-observable variables that played a role in choice decisions. In order to avoid collinearity, we had to exclude one of the ASCs from the models; we chose to keep the alternative specific constant associated with the status quo option, which is a dummy variable that equals one when the status quo option was chosen. We thus had a unique ASC, which took the form of an explanatory variable, in the models: it is denoted 'α_j'.

3.2 Conditional Logit model

Conditional logit (CL) model is defined such that it includes only choice-specific characteristics as explanatory variables. In that case, the vector of attributes X_j does not include any variable that would be invariant from a choice to another. Besides, model parameters are independent from the choice of alternative j. Hence, 'X_j' is a combination of the levels of site-specific attributes[14] in j (ie, 'X_j' is a vector of alternative j-specific regressors) and

[13] The models will be detailed further in Section 3.2 and Section 3.3.

[14] When econometrically estimating the model, the site-specific attributes-related variables had to be coded. Because these attributes were qualitative in nature, a special coding was used. In order to estimate values for each level of attributes (including status quo level), we chose to use 'effect coding'. It consisted of creating a 'code variable' for each site-specific attribute, which took value '1' if the improvement level appeared in the chosen alternative and value '-1' if the status quo level appeared. Thanks to this special coding, we were able to estimate an implicit price for each level of site-specific attributes.

'β' is the vector of preference parameters associated with X_j. Therefore, the functional form of the indirect utility function when 'i' choosing 'j' is:

$$U_{ij} = \alpha_j + X_j'\beta_x + P_j'\beta_p + \varepsilon_{ij}. \tag{6}$$

We specify the price coefficient to be fixed while allowing the other coefficients to vary. According to the assumptions above, the conditional logit specification thus implies that the probability of alternative 'j' being chosen over all the other alternatives of the choice set t can be written as:

$$P(y_i = j|t) = \frac{\exp(\alpha_j + X_j'\beta_x + P_j'\beta_p)}{\sum_{h\in t}\exp(\alpha_h + X_h'\beta_x + P_h'\beta_p)}. \tag{7}$$

This model enables to measure the effect of each choice-specific explanatory variable on the individual choices. Estimates of this model will be presented in Section 4.

3.3 Random parameters Logit model

A limitation of the conditional logit model is that it assumes homogeneous preferences. However, it is not realistic that individuals have the same preferences. In order to solve this problem, we suggested a random parameters (RP) logit approach (the latter is also known as 'mixed logit' (Revelt and Train, 1998[20])). This model is obtained by assuming that the parameters β_x are normally distributed. Then the functional form of the indirect utility function is such that:

$$\begin{aligned} U_{ij} &= \alpha_j + X_j'\beta_i + P_j'\beta_p + \varepsilon_{ij} \\ &= \alpha_j + X_j'\beta_x + P_j'\beta_p + X_j'\nu_i + \varepsilon_{ij} \end{aligned} \tag{8}$$

where $\beta_i = \beta_x + \nu_i$ and $\nu_i \sim N(0, \Sigma_{\beta_x})$. β_x is the population mean and ν_i is the stochastic deviation which represents the individual's preference relative to the average preferences in the population. The combined error $(X_{ij}'\nu_i + \varepsilon_{ij})$ is now correlated across alternatives, whereas the ε_{ij}'s alone were not.

This model specification assumes that preferences relating to the four site-specific attributes are heterogeneous while preferences towards the price attribute are homogeneous. We are thus implicitly assuming the same marginal utility of money for all respondents.

Conditional on the unobservable ν_i, the RP logit specification implies that the probability of alternative 'j' being chosen over all the other alternatives of the choice set t can be written as:

$$P(y_i = j|t)|\nu_i = \frac{\exp(\alpha_j + X_j'\beta_x + P_j'\beta_p + X_j'\nu_i)}{\sum_{h\in t}\exp(\alpha_h + X_h'\beta_x + P_h'\beta_p + X_h'\nu_i)}. \tag{9}$$

The RP logit model allows for variation in preferences across individuals and adjusts for error correlation across alternatives. Model estimates are given in Section 4.

Up to now, our specifications did not include any individual characteristics. Variations in parameters that are related to observed individual characteristics can be captured in logit models through interaction of respondents' characteristics with attributes of the alternatives. We suggested a RP logit model with demographic variables in order to estimate implicit prices specific to individuals'types. We thus estimated a model that includes the income of the respondent interacted with the price attribute. This enabled to examine how incomes affected the probability of an alternative being chosen. Results are presented in Section 4.

3.4 IIA hypothesis

The conditional logit specification implies that selections of an option from the choice set must obey the 'independence from irrelevant alternatives' (IIA) property. The latter states that the relative probabilities of two alternatives being chosen from a choice set are unaffected by the introduction, or removal, of other alternatives in that choice set. In other words, if an alternative A is preferred to an alternative B out of the choice set $\{A, B\}$, then introducing a third alternative θ (thus expanding the choice set to $\{A, B, \theta\}$) must not make B preferable to A. Therefore, whether A or B is better should not be changed by the availability of θ, which is irrelevant to the choice between A and B. This property follows from the assumption that the random components of utility are independently and identically distributed; more precisely, it follows from the independence of the error terms across the different options contained in the choice set.

Hence we have to test for violations of the IIA assumption. The most widely used test is the one developed by Hausman and McFadden (1984[10]). The idea of this test is the following: the IIA hypothesis will be violated if parameters estimates obtained through maximum likelihood estimations of the conditional logit model on different sub-samples of the initial complete sample systematically differ. Each sub-sample results from the exclusion of both an alternative from the complete choice set, and data on choices made by individuals who had selected this particular alternative. The test statistic thus is:

$$T = (\hat{\beta}_r - \hat{\beta})'(\hat{V}_r - \hat{V})^{-1}(\hat{\beta}_r - \hat{\beta}) \overset{H_0}{\sim} \chi^2(m)$$

where $\hat{\beta}$ and $\hat{\beta}_r$ are the parameters' maximum likelihood estimates respectively obtained from complete and restricted data, and $\hat{V}$ and $\hat{V}_r$ are the estimated covariance matrices. Under the null hypothesis that the IIA assumption is valid, the test statistic T follows a Chi-2 distribution with m degrees of freedom, where 'm' is equal to the rank of the matrix $\hat{V}_r - \hat{V}$. The IIA property will not be violated if the test is valid for each sub-sample that can be constructed in removing an alternative from the complete choice set; that is, the test has to be conducted as many times as there are choice subsets. However, if the IIA assumption is violated (ie, if the null hypothesis is rejected), then more complex statistical models are necessary. The RP logit model relaxes IIA by allowing parameters in the CL model to be normally distributed. This is an additional justification for an RP logit model, which would be well appropriated in case of violation of IIA hypothesis by our conditional logit specification.

3.5 Estimation technique

From an econometric viewpoint, data were such that, for each individual, there were as many observations as choice questions she was asked to answer (ie, there were $T = 4$ observations per individual). The conditional logit model was used to estimate choice-specific data through maximum likelihood. Suppose that our sample was made of I individuals, each making T choices. Each choice set is made of $J = 3$ alternatives. Let us define 'δ_{ijt} as being a dummy variable such that:

$$\delta_{ijt} = \begin{cases} 1 & \text{if individual } i \text{ had chosen alternative } j \text{ from the choice set } t, \\ 0 & \text{otherwise.} \end{cases}$$

Hence, the likelihood function corresponding to our conditional logit model can be written as:

$$L(\beta_x, \beta_p) = \prod_{i=1}^{I} \prod_{t=1}^{T} \prod_{j=1}^{J} (P(y_i = j|t))^{\delta_{ijt}}. \tag{10}$$

Then, taking the logarithm of L gives us the log-likelihood function associated with our conditional logit model. Parameter estimates can be derived from the latter equation.

Now turning to our random parameters logit model, a maximum likelihood estimation would require integrating over ν_i. This would amount to compute a high-dimensional integral. Hence the log-likelihood is approximated by a simulator that is based on S draws of ν_i from the normal given current estimates of Σ_{β_x}. The maximum simulated likelihood estimator then maximizes the logarithm of $L(\beta_x, \beta_p) = \prod_{i=1}^{I} \prod_{t=1}^{T} \prod_{j=1}^{J} (\tilde{P}(y_i = j|t))^{\delta_{ijt}}$, where $\tilde{P}(y_i = j|t)$ is a simulator for $P(y_i = j|t)$. Here the frequency simulator is a smooth simulator.

3.6 Willingness-to-pay

Estimates of consumers surplus associated with changes in the level of attributes can be derived from that maximum likelihood estimation of the conditional (or random parameters) logit model. When estimating the model, if 'X' is composed of 'X_1, X_2, $\cdots$, X_a' attributes, then the parameter estimate of the specific attribute 'X_a', denoted 'β_a', can be interpreted as the marginal utility of that attribute, and the parameter estimate of the price attribute, denoted 'β_p', as the marginal utility of money. Hence, observing the choices that individuals make when some attribute level changes and observing the price associated with this particular scenario of change, we can derive marginal values for each attribute when moving from the initial (ie., status quo) level of the attribute to the final (ie., 'good ecological status') level of this attribute. Therefore, the marginal willingness-to-pay (also called implicit price) associated with an improvement in the quality of any attribute 'a' is given by the formula:

$$WTP_a = -\frac{\beta_a}{\beta_p} \tag{11}$$

This gives us a value for an improvement in the quality of the recreation site 'a' in comparison to the current situation; the status quo thus provides the basis for economic valuation of the attributes of the study good. Choice Experiment enables to measure, ex ante, the effects of an improvement in water quality in terms of individual welfare. Since we specify the price coefficient to be fixed while allowing the other coefficients to vary, then the willingness-to-pay for each attribute is thereby distributed in the same way as the attributes's coefficient.

3.7 Zero bids and status quo responses

In CE studies, when a status quo option is available in the choice sets, it is usually selected by a significant proportion of respondents. In addition, it is often the case that a significant proportion of respondents always report the status quo option irrespective of the choice set she is presented. In both cases, status quo responses are considered as being zero bids, and may be categorized into two types. The first are 'true zero bids' (also known as 'genuine zero bids'), where the respondent indicates that she is not willing to pay anything because she is truly averse or indifferent to the good for which a WTP is solicited or because the current situation suits her perfectly (Carlsson and Martinsson, 2001[5]). In other words, such a respondent does not value the good in a utility sense. In that case the respondent really places a zero value on the good. The second are 'false zero bids' (also known as 'protest bids'), where the respondent reports a zero WTP even though her true value for the good in question is positive. This expresses a protest behavior from the respondent; it usually reflects an aversion to the principle of paying for environment conservation or to the payment vehicle or to the change[15]. A respondent who states a zero bid because she is uncertain about the trade-offs she will be willing to make, or because the task of selecting options is too complex (ie, she has difficulties understanding or answering the choice questions), is also considered as being a 'false zero'. Indeed, as for protest bids, she does not express her true WTP. As mentioned before in Section 2.3, protest bids were distinguished from genuine zero bids by asking respondents why they were unwilling to pay for water quality improvement. Those answering either that it was of no worth to them, or that they could not afford it, were classified as true zeros. Other responses were classified as false zeros. Eventually, respondents who answered that they 'did not know' whether they would be willing to pay were also classified as false zeros.

A status quo response in the context of hypothetical survey do not necessarily mean that

[15]For example, such a protest behavior could be due to doubts over the ability of resource managers to carry out the management programs as described in the questionnaire.

the respondent would not pay anything if she was required to do so in reality. Therefore some respondents chose not to state their true (or real) WTP, and so reported false zero bids. Estimates may thus be biased because of protest bidding.

In order to study if such strategies affect implicit prices associated with attributes, we excluded respondents who reported protest bids from the conditional logit modeling. That is, the analysis was restricted to only individuals who stated positive bids and true zero bids. This was made possible because samples used were not self-selected[16]. Indeed individuals who reported their 'real' values for the good in question were not different from those individuals who reported protest bids. The idea was to compare estimations obtained from the entire sample of individuals with those obtained from the sub-sample of individuals who reported their 'real' values. Results are given in Section 4.3.

4 Results and discussion

4.1 Choice Experiments results

Table 1 presents the estimates[17] of the two models. The first one is the so-called conditional logit model [Column *(2)*]; it includes the four site-specific attributes, the price attribute and alternative-specific constant for status quo option. As discussed above, this constant is representing all determinants of utility that a respondent gets out of the choice of each option, but that are not captured by the attributes. Other estimates reported in this table [Column *(3)*] are based on a random parameter logit model.

Turning first to the conditional logit estimates, all site-specific attributes have positive signs and are statistically significant below the one percent level. Achieving good ecological status in water at one site thus brings the respondent additional utility, ceteris paribus. The price attribute has the expected negative sign and is also statistically significant below the one percent level. Indeed it is not surprising that an increase in the monetary price associated with a particular scenario negatively affects utility got from the choice of that scenario. As for the alternative-specific constant, it has a positive sign and is statistically significant below the one percent level. Therefore, the respondent gets some disutility when choosing an improvement scenario; it somewhat takes the form of a 'cost' that is incurred by the individual when choosing a change option (ie. a cost to change). Note that this phenomenon of the utility associated with moving away from the current situation being negative and significant is considered as a form of 'status quo bias' (Adamowicz et al., 1998[1]). Turning next to the random parameters logit estimates, the four site-specific attributes have the expected positive signs and are statistically significant below the one percent level (except the River

[16] Sample selection bias may arise when excluding from the sample of data some individuals that are very different from those individuals who are used to run the analysis.

[17] The statistical softwares SAS and STATA were used to estimate the models.

Table 1: Models estimates

(1)	*(2)*	*(3)*
Variable	**Parameter estimates**	
	Conditional logit	Random parameters logit
Constant for status quo option	0.9692***[0.0856]	1.3606***[0.2603]
Coastline	0.3543***[0.0249]	0.4052***[0.0788]
River Touques	0.2242***[0.0244]	0.3586***[0.0786]
River Dives	0.3718***[0.0250]	0.6647***[0.1618]
River Vie	0.1644***[0.0243]	0.1497**[0.0629]
Price	-0.0169***[0.002271]	-0.0303***[0.006800]
Standard deviations of parameters		
$\sigma(Coastline)$	-	1.1065***[0.3550]
$\sigma(RiverTouques)$	-	0.5629*[0.2998]
$\sigma(RiverDives)$	-	0.0605 [0.2976]
$\sigma(RiverVie)$	-	0.8562***[0.3280]
Log-likelihood	-3305	-3299
N	824	824

Standard error in parentheses; Significance levels: '$*$' = 10%; '$**$' = 5%; '$***$' = 1%

Vie-specific attribute which is statistically significant below the five percent level). Likewise, the price attribute has the expected negative sign and is statistically significant below the one percent level. Thus, with respect to the attributes, both estimators are generating similar results (although all parameters estimates increase in absolute value when we estimate a RP logit model rather than a simple CL model).

Hence the results reported in Table 1 tell us that people not only value improvements in water quality but are also willing to pay for them; moreover, such improvements are valued even more the lower the monetary cost associated with obtaining them.

Table 1 also shows the estimated standard deviations for the parameters of the RP logit estimates. They are all significant (except the one associated with River Dives attribute), indicating that parameters do indeed vary in the population. This confirms our idea that there is preference heterogeneity in the sample.

Table 2 presents the implicit prices, obtained by applying Equation (11) to the estimates of both models, along with their standard errors and significance levels[18]. These prices stand for the amount of money individuals are willing to pay for the management program that corresponds to the specified improvement given in the table being carried out. All these prices are positive and all are statistically significant below the one percent level (except the one for River Vie when estimated from the RP logit estimates, which is statistically significant below the ten percent level). The sets of implicit prices obtained from the conditional logit are

[18]Significance levels were computed using the delta method.

Table 2: Willingness-to-pay (or implicit prices) estimates for improvements in water quality

(1)	*(2)*	*(3)*	*(4)*
Site-specific attribute	**Improvement**	**Implicit price (€ per year and per household)**	
		Conditional logit	Random parameters logit
Coastline	From bad to good	21.02***[3.02]	13.38***[2.74]
River Touques	From moderate to good	13.30***[2.21]	11.84***[2.51]
River Dives	From bad to good	22.06***[3.13]	21.95***[3.38]
River Vie	From poor to good	9.76***[2.01]	4.94*[2.53]

Standard error in parentheses; Significance levels: '*' = 10%; '**' = 5%; '* * *' = 1%

higher than those obtained from the RP logit. The values tell us that individuals are willing to pay more for the improvement in water quality of the River Dives compared to the other basins. Therefore priority is given to restoration of the River Dives; then importance given to the restoration of the other sites is ranked as follows: individuals prefer an improvement in coastal waters, then in River Touques catchment, and finally in River Vie catchment.

As described above, welfare measures for improvement programs at the global river basin can be calculated as the amount of 'payment' required to make the average individual as well off with the improvement program as she is with the current situation. Thus, focusing on the values associated with changes in attributes, we can calculate, for example, a linear measure of welfare in the case of 'good ecological status' achievement in all four sites; it is equal to 66.1 € per year and per household with the conditional logit estimates and 52.1 € per year and per household with the random parameters logit estimates.

Table 3 reports the results of the Hausman test for IIA validity. This test was carried out on a sample obtained by excluding option B from choice sets (and as a consequence by excluding respondents that had chosen this option from the overall sample)[19] and on a sample obtained by excluding the status quo option from choice sets (and as a consequence by excluding respondents that had chosen this option from the overall sample).

In the first case, the test resulted in the rejection of the null hypothesis with the Hausman statistic being large. In the second case, the test resulted in the acceptation of the null hypothesis, but with the Hausman statistic not being statistically significant. Thus, the IIA property was rejected, so that estimating the model as a conditional logit could generate misleading results.

It is worth noting that 33.8% of respondents selected the status quo option for all four of the choice questions they were asked. This percentage is large, so the reader should keep in mind that the results may be biased because of false zero bids (see discussion in Section 3.7).

As mentioned in Section 3, we then present a random parameter logit model that in-

[19]Note that we obtained similar results when excluding option A.

Table 3: Hausman test for IIA hypothesis

(1)	*(2)*	*(3)*
Sample	Statistic	Significance level
Without option B	29.98	0.000097
Without status quo option	5.03	0.4121

cludes some covariates in addition to the variables already included in the RP logit specification. The goal was to take into account individual heterogeneity. The covariates take the form of respondent-specific control variables, and the ones included in the specification were household income. The model thus includes the income of the respondent interacted multiplicatively with the price of the option.

Table 4: RP logit estimates specific to individuals'types

(1)	*(2)*
Variable	**Parameter estimates**
	Random parameters logit
Constant for status quo option	1.2048***[0.2418]
Coastline	0.3869***[0.0788]
River Touques	0.3253***[0.0671]
River Dives	0.5674***[0.1569]
River Vie	0.1501***[0.0553]
Price*Income1	-0.0523***[0.0121]
Price*Income2	-0.0238***[0.0075]
Price*Income3	-0.0381***[0.0091]
Price*Income4	-0.0202***[0.0069]
Price*Income5	-0.0176**[0.0076]
Price*Income6	-0.0139**[0.0069]
Price*Income7	-0.0193*[0.0099]
Standard deviations of parameters	
$\sigma(Coastline)$	0.8693***[0.3331]
$\sigma(RiverTouques)$	0.3939 [0.3711]
$\sigma(RiverDives)$	0.0795 [0.2367]
$\sigma(RiverVie)$	0.6605*[0.3782]
Log-likelihood	-3276
N	824

Standard error in []; Significance levels: '$*$'=10%; '$**$'=5%; '$***$'=1%

Monthly income: '1' = less than 750 €; '2' = [750 €; 1200 €[;

'3' = [1200 €; 1600 €[; '4' = [1600 €; 2100 €[; '5' = [2100 €; 2500 €[;

'6' = [2500 €; 3600 €[; '7' = more than 3600 €

We obtained estimates specific to individuals' types. Table 4 reports the results of this model. All site-specific attributes have positive signs and are statistically significant below the one percent level. Furthermore, the price attribute still has a negative sign when multiplicatively interacted with household income and it is statistically significant. Results show that willingness to pay for each attribute varies with income. The higher the respondent's household income is, the more she gets utility out of the choice of an improvement option. The standard deviations are low and only two of them are statistically significant. This indicates that variations in willingness to pay are well captured by the income. For example we notice that households whose income is less than 750 € are willing to pay 7.40 € per year for good ecological status at coastal waters. No exhaustive table with all willingness to pay resulting from this model is presented in the paper.

4.2 Cost-Benefit Analysis

In the particular context of the Water Framework Directive, we aimed at running a cost-benefit analysis. This consists of first, estimating the equivalent money value of the benefits and costs to the achievement of a good ecological status in the river basin and then, comparing those values to establish whether the management project is worthwhile.

The choice experiment method enabled us to estimate implicit prices per household and per year. Therefore we were able to compute the non-market benefits that would arise from an improvement in the quality of the basin waters. When the WFD was adopted, the French water agencies were asked to define the measures necessary to reach the good ecological status and also to estimate the costs associated with them. Then turning to the assessment of the costs, we used data available in the urban development plan for water management[20] in Normandy. Benefits[21] and costs estimates are available in Table 5.

Then we were able to compute the net present value for the achievement of a good actual status by 2015. It is defined as the sum of the present values of each cash flow. This value can be computed using the following formula:

$$NPV = \sum_{t=0}^{T} \frac{B_t - C_t}{(1+r)^t} \tag{12}$$

where B_t are the annual benefits, C_t are the annual costs, such that $B_t - C_t$ is the net cash flow. Moreover, t stands for the time of the cash flow (that is for the year) and r for the discount rate.

[20] A urban development plan for water management sets the basic guidelines for a balanced management of water resources in the public interest and in compliance with the principles of water law. Among other things, it defines the costs necessary to reach a good ecological status in each river. In the context of the WFD, each French water agency was asked to design such a plan for the river basins they are in charge of.

[21] We computed the benefits using the conditional logit model estimates.

Table 5: Cost-benefit analysis

	Per year and per household	Per year	Present value
Benefits	52.1 €	4.65 Millions €	62.1 Millions €
Costs	295.9 €	26.4 Millions €	474.8 Millions €
Net Present Value (NPV)	-412.7 Millions €		
Net benefit-cost ratio	13.07%		

N.B.: T=29; r=4%

As recommended by the Directive, we computed the NPV on the period of time 2010-2040. Hence the costs were taken into account on a 30-year period. Because the WFD provides for the achievement of a good ecological status by 2015, the benefits were only entered in the accounts from 2015. In France, the discount rate is set at 4% when public investments are discounted on a maximum of 30 years.

Table 5 presents the cost-benefit analysis. We found a negative NPV, which means that the management project is not worthwhile. Because costs easily outweigh the benefits accruing from good ecological status, they could be considered as disproportional. The achievement of good ecological status in the river basin could benefit from a deferment period.

4.3 Further comparison: exclusion of protest bids

As discussed above in Section 3.7, 33.8% of the respondents always chose the status quo option when answering the choice questions. Moreover, these zero bids can be categorized into two types: genuine zero bids and protest bids. Then the idea was to examine wether those protest bids affected model estimates. When splitting the entire sample into a sample made of 'real bids' and a sample made of 'protest bids', we observed that these two sub-samples were not self-selected. Hence it was made possible to estimate the random parameters logit model on the 'real bids' sample (note that there were 655 respondents in the database after exclusion of protest bids).

Table 6 reports the estimates of this model. On one hand, all site-specific attributes have positive signs and are statistically significant below the one percent level. Once more the price attribute have a negative sign and is statistically significant below the one percent level. The RP logit estimates obtained from the regression on the 'real bids' sample are higher (in absolute value) than the one obtained from the regression on the entire sample. This suggests that protest bids do affect attributes-related parameter estimates. On the other hand, the alternative-specific constant has a positive sign and is statistically significant below the five percent level. It is important to note that this constant strongly decreases with respect to the estimates in Table 1 Column (3). This suggests that, when excluding false zero bids from the sample, the cost to change induced by the choice of an improvement

Table 6: Model estimates when excluding protest bids

(1)	*(2)*
Variable	**Parameter estimates**
	Random parameters logit
Constant for status quo option	0.7185**[0.3496]
Coastline	0.7505***[0.2181]
River Touques	0.4207***[0.1081]
River Dives	0.8735***[0.2407]
River Vie	0.2565***[0.0824]
Price	-0.0384***[0.00946]
Standard deviations of parameters	
$\sigma(Coastline)$	-1.1498***[0.3618]
$\sigma(RiverTouques)$	-1.0362**[0.4753]
$\sigma(RiverDives)$	-0.0323 [0.3385]
$\sigma(RiverVie)$	1.1673***[0.4440]
Log-likelihood	-2438
N	655

Standard error in parentheses;

Significance levels: '$*$' = 10%; '$**$' = 5%; '$***$' = 1%

option strongly decreases. This intimates that respondents tried to signal their aversion to the change through their protest bids.

Table 7 presents the implicit prices along with their standard errors and significance levels. All these prices are positive and all are statistically significant below the one percent level.

The sets of implicit prices generated by estimations of the RP logit models on both sub-samples differ, the WTP and the standard errors obtained from the 'real bids' sample being larger. The fact that these prices are modified when estimating the model on the sub-

Table 7: Willingness-to-pay estimates when excluding protest bids

(1)	*(2)*	*(3)*
Site-specific attribute	**Improvement**	**Implicit price € per year and per household**
		Random parameters logit
Coastline	From bad to good	19.52***[3.19]
River Touques	From moderate to good	10.94***[2.58]
River Dives	From bad to good	22.72***[3.68]
River Vie	From poor to good	6.67***[2.00]

Standard error in parentheses;

Significance levels: '$*$' = 10%; '$**$' = 5%; '$***$' = 1%

sample where protest bids are excluded rather than on the entire sample demonstrates that controlling for the presence of protests bids in the sample does matter much.

5 Conclusions

In this paper, we applied the method of choice experiments to water management decisions in the context of the Water Framework Directive. We presented an empirical example of using spatial attributes in order to see wether people are willing to pay for improvements in water quality and, should this happen, what values they place on such improvements. We selected four site-specific attributes, which were some watercourses belonging to a single river basin, and we defined two levels for each of them: the first one represented the current ecological status and the second one the 'good ecological status' (as defined in the Directive).

On the basis of the trade-offs that respondents make among attributes when good status cannot be supplied simultaneously at all sites, we managed to estimate implicit prices for water quality improvement at each site. Therefore we found that people place significant positive values on these sites, which means that they are willing to pay for the management plans described in the questionnaire being carried out. Moreover, we found that the respondent's income positively influence the willingness to pay for an improvement in water quality.

Implicit prices estimates enabled us to measure the non-market benefits that would arise from an improvement in the quality of water. Then using estimates made by French water agencies regarding the costs of measures that have to be implemented to achieve a good status, we were able to carry out a cost-benefit analysis. We found that costs amply exceed benefits accruing from good ecological status. In that case, the cost-benefit analysis could provide some economic justification for a deferment period with regard to the achievement of good ecological status in the water basin.

Another purpose of the paper was to see whether protest bids affect the model estimates. This was thought to be important since more than 20% of the respondents reported false zero bids (that is to say that they do not state their real value for the good). Thus, excluding protest bids from the analysis and then re-estimating the model provided results that differ to those previously obtained. This suggests that protests bids do affect the outcome. It is important to note that exclusion of false zero bids was made possible because the samples used were not self-selected. However, this form of 'sample selection bias' may arise; in that case, we are not aware of any way of addressing this problem in the model estimation. Hence, research work need to progress on developing a statistical framework that would enable to 'treat' the protest bids more thoroughly when running the analysis.

Finally, choice experiments seem to be useful in the context of the Water Framework Directive, since they can take into account variations in both environmental and socio-economic characteristics across sites. Moreover, they allow to compare costs and benefits of catchment management plans, as it is imposed by the WFD. However, CE studies are expensive and time-consuming. Hence, it is very likely that regulators are reluctant to order original valuation studies for every catchment. Therefore, in order to implement the WFD in all Europe, it could be worth setting up a system of benefits transfer, which consists of taking estimates from one study site and applying them to other 'policy sites' (this can only be done if certain statistical conditions are proved to be valid).

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