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Full Length Research Paper

Valuing environmental impacts of coastal development projects: A choice experiment application in Spain

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This paper presents the results of an empirical application aimed at estimating the economic value of the potential environmental impacts to mount Jaizkibel (Spain) resulting from the construction of a new seaport over its hillside. A choice experiment technique is applied for an *ex-ante* natural resource damage assessment in monetary terms. The results revealed that, depending on the extent of the environmental damage, the social welfare loss would be between 172 and 535 million Euros per annum.

Key words: Choice modelling, environmental valuation, social welfare, coastal management.

INTRODUCTION

Sea coast is an appreciated natural resource for human beings because of the ecological, cultural, social and economic values it bears. Human settlements have historically established near the coast. With just 4% of Earth's total land area, coastal areas and small islands house more than one-third of the world's population (Barbier et al., 2008). This is also the case of Spain. With a coastline 8,000 km long (4,000 km of cliffs, 2,000 km of beaches, 1,000 km of low coast, and around 600 km of artificial areas), it is estimated that nearly half of its population live in its coastal zones. Human pressure over the Iberian coast has increased over the last decades. In the Basque Country, a Spanish region in the North of the Iberian Peninsula, land artificialisation has grown 14% between 1987 and 2000, and the surface occupied by seaport areas has grown 72% for the same period, from nearly 366 ha in 1987 to 629 ha in 2000 (OSE, 2007). Developmental monetary benefits are often raised as a justification for diverse coast artificialisation projects, but they are rarely confronted with the environmental benefits that its conservation may entail. The absence of a monetary expression for the goods and services provided by coastal natural ecosystems often implies that they are implicitly equalled to zero. Scarcity of quantitative information for policy decision making has often been a concern of coastal managers (Christie and White, 1997; Chua, 1993).

Economic valuation aims at providing estimates of willingness-to-pay (WTP) of citizens to achieve/avoid certain environmental quality changes. Different economic valuation techniques have appeared to estimate in monetary terms the value of non-market goods. Existing approaches are broadly grouped into revealed preferences methods (like hedonic pricing and travel cost) or stated preferences methods (like contingent valuation and choice experiments). Stated

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preference methods have received growing attention mainly due to their flexibility and ability to measure not just use values (as revealed preference methods) but non-use values of natural resources as well (Mitchell and Carson, 1989). The main difference between the Contingent Valuation Method and the Choice Experiment (CE) methodology is that while in the former individuals face the valuation of one good with varying prices, in the latter individuals face the valuation of a bunch of goods (or one good with multiple attributes) and different prices. The underlying idea of CEs is that if human-induced changes in the state of an ecosystem can be coherently represented by a group of attributes, people's choices provide substantial information over their preferences regarding alternative states of the environment (Hoyos, 2010).

This paper examines the use of a CE methodology to assess the economic value of potential environmental impacts that could be associated with the construction of a new seaport over the hillside of mount Jaizkibel (Spain). Jaizkibel is a protected natural resort because of its landscape and geological interest as well as its fauna, flora, and seabed. The values obtained can be employed in an *ex-ante* assessment of the environmental costs associated with coastal development projects useful for decision making.

Case study

Pasaia, a city located on the Spanish Cantabrian coast, near the border with France, has had maritime and commercial activities in its natural port since the 12th century. Even though up to the 19th century it was mainly dedicated to ship building and fishing, its main activity during the 20th century has been the traffic of materials from heavy industry. In recent years, the Port Authority of Pasaia has promoted a project to develop a new seaport outside the bay, in front of mount Jaizkibel. Defenders of this project claim that it will be very profitable to the economic activity of the region while opponents argue that the environmental loss associated with the project advice against its construction. Figure 1 shows the current seaport (A) and three projected seaports (Seaport projects 1, 2 and 3), with different capacity and affections to Jaizkibel natural site.

Mount Jaizkibel is a 2,434 ha natural site located at 1° 50' West longitude and 43° 22' North latitude. It belongs to the European Natura 2000 Network because it is considered a site of Community importance for the Atlantic biogeographical region, thus protected under European environmental legislation (Habitat Directive 92/43/EEC). The landscape of this area is especially interesting because the mountain goes along the coast with abrupt falls in the western part, forming cliffs up to 240 m high. The cliffs are considered of geological interest due to the layout of sandy stratum. They host the *Armeria euskadiensis*, an endemic plant of the Basque coast catalogued as an endangered species. In the Eastern part, the terrain is not so abrupt and there are small beaches and precipices formed by the curse of streams ending in the Cantabrian Sea. In these areas, one can find some interesting species of flora such as tropical ferns (*Woodwardia radicans* and *Trichomanes speciosum*), very rare in the rest of Europe. Certain spaces maintain the original tree cover, oak grove of *Quercus robur* and *Quercus pyrenaica*. The rest of Jaizkibel conforms a non-wooded forest area with some brushes and some pastures associated to local *baserri* (autochthonous farms).

Some colonies of lesser black-backed gull and yellow-legged gull (*Larus fuscus* and *Larus cachinnans*) nest in Jaizkibel's cliffs. Other interesting birds, such as the European storm-petrel (*Hydrobates pelagicus*), Green cormorant (*Phalacrocorax aristotelis*) and Peregrine falcon (*Falco peregrinus*) can be found in this natural area. Over the mainland there are numerous species of amphibious, reptiles and mammals such as Palmite newt (*Triturus helveticus*), Midwife toad (*Alytes obstetricans*), Dark green snake (*Coluber viridiflavus*) and Greater horseshue bat (*Rhinolophus ferrumequinun*). In its seabed, it harbours different types of molluscs, sea urchins and crustaceans. Jaizkibel's seabed also harbours various types of seaweed: green, red and brown. Furthermore, Jaizkibel has one of the most important lands of red seaweed of the Basque coast. In short, Jaizkibel's most outstanding environmental attributes are: landscape, autochthonous fauna and flora, seabed life, and environmental services such as sweet water, clean air and maintaining of current stream, swell and sediment transportation regime.

The construction of a new seaport would involve a number of different stressors that could damage natural site's landscape values, habitats and species. The identification of potential damages was based on published reports, public institutions' and NGOs' reports and assessments made at the site. According to these information sources, anticipated environmental impacts related to the construction and operation of the seaport would include: direct loss of habitat, disturbance to sensitive habitats and species of avifauna, air pollution, increased human access to wildlife, risk of fire and other disturbance to sensitive habitats and species. Detailed information on the environmental values and potential damages to Jaizkibel may be found in Pozueta (2004).

Survey design

A valuation survey was conducted in the Basque Country in order to determine the value of the potential environmental impacts to Jaizkibel area. The questionnaire

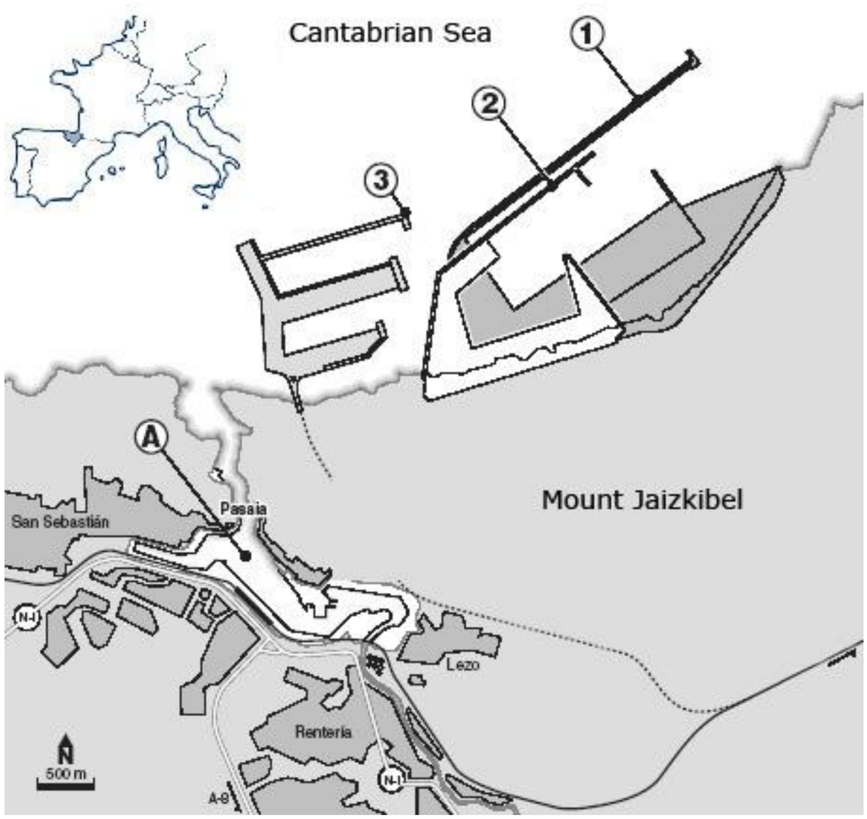

Figure 1. Three scenarios for the future seaport of Pasaia.

started by describing the Jaizkibel natural site. Next, certain changes in the quality of mount Jaizkibel's main attributes were described. It was stated that if the site was not to be protected in the future, it could be affected by human activities. The market institution was detailed next, where compulsory monetary contributions from the Basque residents would contribute to the conservation of the site. The trade-offs between payments and degree of preservation of the different attributes were presented in choice sets of two alternatives and an opt-out situation, as will be detailed shortly. The final part of the questionnaire was devoted to some debriefing and sociodemographic questions. The selection of attributes and levels is an important aspect in CE given that respondents are to make choices characterized by those attributes and levels (Hensher, 2007). Previous investigation on environmental characteristics of Jaizkibel natural site, experts' advice and focus groups facilitated the definition of environmental attributes and levels of provision. Furthermore, a pilot survey using open-ended contingent valuation questions helped in identifying the appropriate levels of the payment attribute.

At the beginning, six non-monetary attributes were identified: landscape, flora, avifauna, seabed, groundwater and air quality. However, the last two attributes (groundwater and air quality) were dropped mainly because of their relative little importance as suggested by experts and focus groups. Table 1 reflects the attributes and levels considered in this study. They were,

(1) Landscape, measured by the percentage surface from which today's landscape could be seen in the future;
(2) Flora, measured by the future level of protection of today's population of *A. euskadiensis* endemism;
(3) Avifauna, measured by the future level of protection of today's population of lesser and peregrine falcons;
(4) Seabed, measured by the future level of protection of today's extension of red algae; and
(5) Annual contribution in euros, varying from 5 to 100 €.

Respondents' understanding of the valuation exercise is a critical aspect of any stated preference survey. Accordingly, the graphic and verbal description of the future environmental changes for the non-monetary attributes was tested in detail in focus groups. Landscape changes seemed to be better understood showing pictures with a different degree of visual affection, as shown in Figure 2. The importance of flora, fauna and seabed attributes seemed to be better captured by its most prominent species, the *A. euskadiensis*, the lesser

Table 1. Attributes and levels considered.

Attribute	Level						
Landscape (%)	40*	60	80	100			
Flora (%)	50*	70	85	10			
Fauna (%)	25*	50	75	100			
Seabed (%)	50*	70	85	100			
Annual payment	0 €*	5 €	10 €	15 €	20 €	30 €	50 €	100 €

*Business-as-usual level.

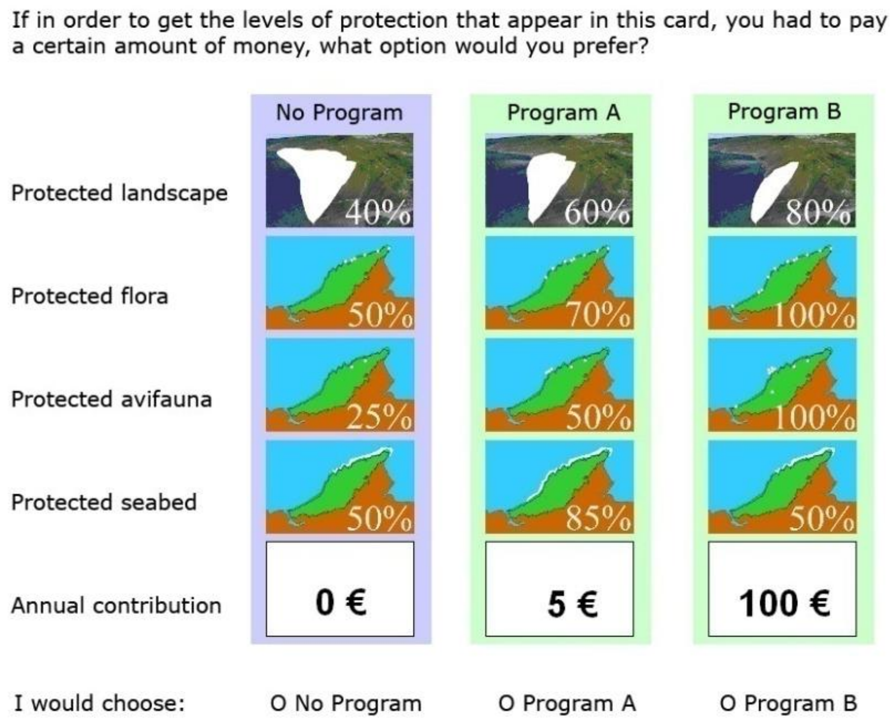

Figure 2. Example of choice set with different protection alternatives used in the valuation exercise.

and peregrine falcon, and the red algae respectively. These attributes' graphical representation corresponded with the actual location of these species' populations according to the experts' advice. When the percentages of protection of these attributes were inferior to 100%, some actual location of its most prominent species' populations were deleted accordingly (Figure 2). None of the levels of protection were set to zero in order to avoid plausibility problems related to the survival of different species.

Combining all these attributes and levels, near two thousand different combinations are obtained (4^4x7^1). A main effects fractional factorial design with second order interactions was used to reduce the number of alternatives to 96 pairs of protection alternatives (Louviere et al., 2000). Further, the alternatives were grouped in 24 blocks of four choice sets containing two alternative protection programmes plus the business-as-usual (BAU) option. The burden of the choice task was checked in the focus groups. As a result, the final version of the questionnaire had four choice sets, each formed by the BAU option plus two protection alternative programs (Programs A and B) as shown in Figure 2. The proposed payment vehicle was an annual contribution to a Foundation exclusively dedicated to protecting Jaizkibel natural site that all Basque citizens would have to make.

The questionnaire was administered through in-person computer-aided individual home interviews. Respondents could read the questions in the computer's screen and listen to a recorded voice, with three different languages available: Basque, Spanish and French. The relevant population considered was the population from the

Basque Country, accounting for 2.5 million people being at least 18 years old. A pilot survey was conducted in October 2006, while the final survey was undertaken between November and December, 2006. A stratified random sample of 600 individuals was selected from the relevant population. The strata used included age, gender and size of the town of residence, following official statistical information from the Basque Statistics Institute (EUSTAT). In each location, the questionnaires were distributed using random survey routes.

METHODOLOGY

CE belongs to the family of conjoint analysis methods, defined by Green and Srinivasan (1990) as "any decompositional method that estimates the structure of a consumer's preferences given his or her overall evaluations of a set of alternatives that are pre-specified in terms of levels of different attributes." Choice experiments technique is based on Lancaster's characteristics theory of value and random utility theory (Hanley et al., 1998). Following random utility theory, consumers pursue the maximisation of utility in decision-making processes. Thus, the utility an individual *i* obtains from alternative *j* (U_{ij}) can be formalised as;

$$U_{ij} = V_{ij} + \varepsilon_{ij},$$

where V_{ij} is the part of utility that is observable (and thus affected by the attributes of this option), and ε_{ij} is the non-observable part or random component. As a consequence, individual *i* will choose alternative *j* instead of *k* if her utility increases, this is, if:

$U_{ij} > U_{ik}$ for $k \neq j$

However, given the existence of a random component, the choices can be written in probability terms. The probability that individual *i* chooses alternative *j* instead of *k* from a finite set of alternatives *C,* would be:

$$P_{ij} = \text{Prob}\{V_{ij} + \varepsilon_{ij} > V_{ik} + \varepsilon_{ik}; \forall k \in C\}.$$

The stochastic component of utility is usually assumed to be independent and identically distributed (IID) and Gumbel distributed (McFadden, 1974). Thus, the conditional logit model can be written as:

$$P_{ij} = \frac{e^{\omega V_{ij}}}{\sum_{k=1}^{m} e^{\omega V_{ik}}},$$

where ω is a scale parameter, which is inversely proportional to the error term's standard deviation and it is generally assumed to be one so that the variance of the error term is constant.

The equation aforestated can be estimated by means of a multinomial logit (MNL) regression. The MNL model relies on the assumption that choices are consistent with the Independence of Irrelevant Alternatives (IIA). This axiom states that the ratio of the probabilities of choosing one alternative over another is not affected by the presence or absence of other alternatives in the same choice set (Louviere et al., 2000). In case of violation of IIA, the parameters estimation would be biased. The IIA property is usually checked using the test proposed by Hausman and McFadden (1984). The structure of the MNL model depends on the form adopted by the indirect utility function. To estimate the main effects, an additive indirect utility function of the following form may be used:

$$V_{ij} = \beta_0 + \beta_1 Atrib_1 + \beta_2 Atrib_2 + \beta_3 Atrib_3 + ... + \beta_n Atrib_n$$

where β_0 is the constant term and β_1 … β_n are the coefficients of environmental attributes.

The constant term, β_0 (that can be interpreted as a vector of alternative specific constants, one for each alternative considered in the choice set) reflects the influence on choice of non-observed attributes relative to specific alternatives. Alternative specific parameters, however, may be dropped in dealing with non-labelled experiments (Hensher et al., 2005). Individual marginal WTP estimates represent the average maximum amount of money a person is willing to give in exchange for an additional unit of the environmental good, that is they represent estimations, *ceteris paribus*, of the value of a marginal change in a given attribute. In order to estimate the WTP, the interaction between multiple attributes, if relevant, is to be taken into account as well as the influence of the alternative specific constant. Welfare estimates for MNL models may be obtained from

$$CS = \frac{-1}{\alpha\left[\ln\sum e^{Vi0} - \ln\sum e^{Vi1}\right]},$$

where *CS* represents the compensating surplus, α is the marginal utility of income, and V_{i0} and V_{i1} are the indirect utility functions of alternative *i* in the status quo (0) and in the change considered (1). In our case, the previous expression can be rewritten as:

$$CS = -\frac{1}{\beta_{\cos t}}\left[\Delta\beta_{landscape} + \Delta\beta_{flora} + \Delta\beta_{avifauna} + \Delta\beta_{seabed}\right]$$

And simplifying the aforestated equation, the marginal value of a change in one attribute with respect to another is measured through the ratio of both coefficients. Therefore, the WTP for each of the environmental attributes is obtained by dividing the coefficient of each attribute by the cost attribute coefficient:

$$WTP = -\frac{\beta_{attribute}}{\beta_{\cos t}}$$

The cost parameter is interpreted as the marginal utility of income.

RESULTS AND DISCUSSION

A fixed parameter logit model specification was estimated using LIMDEP econometric software (Greene, 2007). The results are shown in Table 2. All the coefficients of the environmental attributes have the expected signs (positive, meaning that conservation is more highly valued than loss) and are significant at 1% level. The negative coefficient of the price attribute is also expected, indicating that the probability of accepting an annual

Table 2. Fixed parameter logit model estimation.

Covariate (attribute)	Coefficient	t-Statistic
Landscape	0.02028	7,38
Flora	0.01272	3,79
Avifauna	0.00998	4,90
Seabed	0.00925	3,90
Cost	-0.01462	-7,17
Log-likelihood		-590.4531
Log-likelihood at 0		-627.1635
Observations		687

Table 3. IIA/IID test statistics for the MNL model.

Alternative dropped	X^2	Df	Probability
Business-as-usual	6.462	5	0.264
Alternative 1	0.926	5	0.968
Alternative 2	6.560	5	0.255

Table 4. Marginal WTP for protecting mount Jaizkibel's environmental attributes, in euros 2006 per person and year.

Attribute	Marginal WTP	95% confidence interval
Landscape	1.39	(0.98,1.86)
Flora	0.87	(0.41,1.31)
Avifauna	0.68	(0.41,0.95)
Seabed	0.63	(0.33,0.96)

95% confidence intervals were calculated using the Krinsky-Robb procedure (Krinsky and Robb, 1986).

contribution for protecting mount Jaizkibel's attributes decreases as the price increases. No relevant second order interactions were found. Regarding the IIA property (Hausman and McFadden, 1984), it was tested whether the full mode, estimated with all three alternative choices, was equivalent to a restricted model where one of the alternatives was eliminated. In every case, the null hypothesis that IIA holds for this data set cannot be rejected, as shown in Table 3. Table 4 shows point estimates and 95% confidence intervals of the marginal WTP estimates for the four attributes. The positive signs of the marginal WTP estimates for the environmental attributes indicate that, everything else being equal, respondents would be better off on average with an increase in the level of those attribute. The individual WTP for a 1% improvement of Jaizkibel's landscape is estimated at 1.39 euros (2006) per person and year.

Similarly, the WTP for a 1% improvement in the quality of the flora, avifauna and seabed is estimated at 0.87, 0.68 and 0.63 euros per person and year respectively. Three damage scenarios to the environmental attributes of mount Jaizkibel can be approximated based on the expected impacts associated with the Seaport projects presented in Figure 1. The scenarios are based on the report by Pozueta (2004) and experts' opinions. They took into account the current geographical location of the *A. euskadiensis*, the lesser black-backed gulls and peregrine falcons, and the red algae. Experts' advice was followed in order to determine the specific impact of each harbour project on the population of these species. Figure 3 summarises the main impacts of each project to the identified environmental attributes. This figure shows, for example, that the largest harbour project (seaport 1) would imply that 40% of current landscape, 50% of current flora, 25% of current fauna and 50% of current seabed would remain preserved in the future.

Annual welfare loss due to the environmental degradation provoked in the construction of each future seaport was calculated using the compensating surplus equation for a linear additive utility function explained before. Table 5 shows the individual WTP estimates for each scenario. The WTP corresponds to the mean amount of money, in 2006 values, that one individual would be willing to pay at most to avoid an environmental damage as described for each scenario. Thus, on average an individual would be willing to pay annually an average of 209 euros to avoid an environmental damage as described in the Seaport 1 degradation scenario, 134 euros for the Seaport 2 degradation scenario and 67 euros for the Seaport 3 degradation scenario. Finally, the annual welfare loss associated with the degradation scenarios described above is calculated by multiplying the mean WTP by the relevant population (2.5 million residents), as shown in Table 6. The annual welfare loss of the deterioration of the environmental quality of Jaizkibel associated to the harbour development may be estimated between 172 and 536 million euros, depending on the project to be undertaken. In the Seaport 1 Scenario, annual welfare loss is estimated at 535 million euros (213 million for landscape, 110 for flora, 130 for avifauna and 81 for seabed). In the Seaport 2 Scenario, annual welfare loss is estimated at 344 million euros (142 million for landscape, 66 for flora, 87 for avifauna and 49 for seabed). And, in the Seaport 3 Scenario, annual welfare loss is estimated at 172 million euros (71 million for landscape, 33 for flora, 43 for avifauna and 24 for seabed).

In sum, this empirical application has attempted to show how economic analysis can be used in coastal management in order to assess *ex-ante* the desirability of a development project according to its environmental effects. The ex ante assessment of potential environmental impacts faces two significant shortcomings: absence of market prices for environmental damages and reliance on hypothetical behaviour that can only be

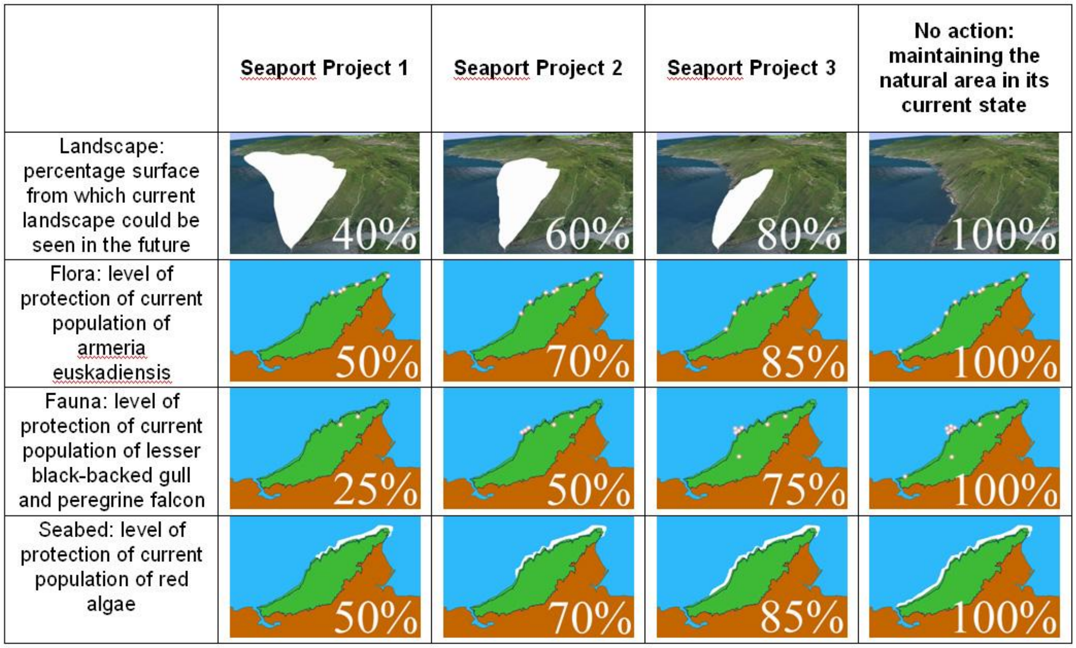

Figure 3. Mount Jaizkibel estimated scenarios according to the impacts of three future seaport projects of Pasaia.

Table 5. Compensating surplus for different degradation scenarios, in euros 2006 per person per year.

Scenario	Level of damage				Individual WTP
	Landscape (%)	Flora (%)	Avifauna (%)	Seabed (%)	
Seaport 1	60	50	75	50	208.74 *(126.26-296.87)*
Seaport 2	40	30	50	30	134.17 *(81.71-190.34)*
Seaport 3	20	15	25	15	67.09 *(40.86-95.17)*

Table 6. Annual welfare loss, in millions of euros 2006.

WTP	Landscape	Flora	Avifauna	Seabed	Aggregate
Seaport 1	212.89 (150.85-287.07)	110.60 (52.57- 168.30)	130.76 (78.32-183.22)	81.16 (42.18-123.01)	535.52 (323.93-761.61)
Seaport 2	141.93 (100.57-191.38)	66.36 (31.54-100.98)	87.17 (52.21-122.15)	48.76 (25.31-73.81)	344.22 (209.63-488.32)
Seaport 3	70.96 (50.28-95.69)	33.18 (15.77-50.49)	43.59 (26.11-61.07)	24.38 (12.65-36.90)	172.11 (104.82-244.16)

captured by SP methods. The use of CE methodology in this context is thus justified by two reasons: first, as a SP non-market valuation technique, it allows to estimate hypothetical environmental quality changes; and secondly, it is able to separately estimate the preference of individuals for different environmental attributes and marginal values. The flexibility of this methodology allows assessing a wide variety of potential damages to a diverse set of environmental attributes.

Some applications of CEs have been reported for the economic valuation of coastal and marine resources (Johnston et al., 2002; Lew and Larson, 2005; Rein, 1999; Samonte-Tan et al., 2007), although, to our knowledge, the use of CE in this context is non existent.

Table 7. Contingent valuation studies of rural landscape changes, with WTP expressed in euros 2006 per person and year.

Study	Landscape change	Population	Individual WTP
Santos (1998)	Conserving the Pennine Dales (ESA, England) landscape's attributes	Visitors	78,84 - 96,17
Willis and Garrod (1991)	Conserving the Yorkshire Dales (UK) today's landscape	Visitors	59,89 - 89,43
Santos (1997)	Conserving today's agricultural landscapes in the Peneda-Geres (NP, Portugal)	Visitors	64,83 - 75,72
Santos (2007)	Multiple study average		42,40 - 64,56
Santos (2007)	Meta-analytical model predictions based on similar studies	Visitors	48,16 - 97,96

Source: Santos (2007).

The WTP results seem to be in line with those from similar studies. Table 7 contains a summary of the mean estimates of different studies and the results from a meta-model built upon contingent valuation studies of environmentally sensitive areas by Santos (2007). In the reported studies, the WTP ranges from 42 to 98 € per visitor and year. These estimates are slightly higher than the WTP for protecting the mount Jaizkibel today's landscape (between 27.80 and 83.40 € per person and year depending on the percentage degradation considered). This difference may be explained, among other things, because the population surveyed in these studies were visitors (normally stating higher WTP than non-visitors) while in Jaizkibel the general population was surveyed.

Conclusions

Coastal managers and policy-makers often need to evaluate policies affecting the welfare of the population. If relevant environmental costs are not incorporated in coastal developmental project assessments, welfare measures will be probably biased. CE methodology is a valuation method that can be used to value impacts related to coastal development projects. This paper has used this methodology to perform an economic assessment of potential non-market environmental damages to Jaizkibel natural site (Spain) associated to the construction of a new seaport in Pasaia. The valuation exercise was based on a questionnaire survey administered in the Basque Country (Spain and France) to a representative sample of the population.

On average a Basque citizen would be willing to pay annually 1.39 euros for avoiding 1% deterioration of mount Jaizkibel today's landscape; 0.87 euros for avoiding 1% deterioration of today's flora; 0.68 euros for avoiding 1% deterioration of today's avifauna; and 0.63 euros for avoiding 1% deterioration of today's seabed. According to this estimates, the economic value of the future environmental damage provoked by a new seaport in Pasaia was estimated between 172 and 535 million euros per annum. This value depends on the future environmental damage that the construction of a new seaport may cause. In case of constructing Seaport 1 (Figure 1), the environmental damage was estimated in 535 million euros per annum. In case of constructing Seaport 2, the environmental damage was estimated in 344 million euros per annum. And last, if Seaport 3 was constructed, the environmental damage was estimated in 172 million euros per annum.

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