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Valuing environmental impacts of coastal development projects: a choice modelling application in Spain

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Abstract

Developmental monetary benefits of coast artificialisation projects are rarely confronted with the environmental benefits that its conservation may entail. As a consequence, policy-makers often face decision making processes in which monetary benefits have to be balanced with physical impacts ending up in undervaluation or overvaluation of environmental aspects. Non-market valuation of coastal and marine resources is thus a growing concern in the assessment of cost-benefit analysis of coastal developmental projects.

This paper attempts to estimate the effects on people's utility of the potential environmental impacts of a new seaport in Pasaia, Spain. A choice modelling technique is proposed as a means of estimating marginal impacts for different environmental attributes of mount Jaizkibel, namely its landscape, flora, avifauna and seabed. The results from a multinomial logit model reveal that, on average, individuals would pay 1.39 euros for a one percentage protection of its landscape; 0.87 euros for protecting its flora; 0.68 euros for protecting its avifauna; and 0.63 euros for protecting its seabed.

Keywords: choice modelling; environmental valuation; social welfare

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1. Introduction

Sea cost is an extremely valuable natural resource for human beings because of the great ecological, cultural, social and economic values it bears. Marine areas are usually more productive and diverse the closer they are to the sea cost. Human settlements have historically taken advantage of this situation by establishing in these areas: with just 4% of Earth’s total land area, coastal areas and small islands house more than one-third of the world’s population [1]. This is also the case of Spain that, with a coastline 8,000 Km long (4,000 Km of cliffs, 2,000 Kms of beaches, 1,000 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 Spanish coastal areas has steadily increased in the last decades mainly due to urban development and port facilities construction. Land artificialisation in these areas increased by 27% between 1991 and 2001. Furthermore, 40% of the land in the first 500 metres of Spanish coast is occupied by artificial areas. The picture of the Basque Country, a Spanish region in the Northwest of the Iberian Peninsula, is no different from that of the rest of Spain. Land artificialisation in the Basque Country has grown at a lower rate (14% between 1987 and 2000) although the surface occupied by seaport areas has grown 72% for the same period, from nearly 366 Ha in 1987 to 629 Ha in 2000 [2].

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. The estimation of an economic value for the environmental goods and services is therefore justified, among other things, by the fact that they can be taken into account in decision-making processes such as Cost-Benefit Analysis (CBA). However, many institutional CBA applications do not value environmental damages in monetary terms but rather are documented in physical terms. As a consequence, policy-makers face decision making processes in which monetary benefits have to be balanced with physical impacts ending up in undervaluation or overvaluation of environmental aspects [3].

Different economic valuation techniques have appeared within the theoretical framework of environmental economics to estimate in monetary terms the value of non-market goods. Existing approaches are broadly grouped into revealed preferences methods (hedonic pricing, travel cost, averting behaviour, defensive expenditure and methods based on cost of illness and lost output) or stated preferences methods (contingent valuation and choice modelling techniques). Since the early 90s, stated preference methods have received growing attention and acceptance 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 [4]. The main difference between the Contingent Valuation Method (CVM) and Choice Modelling (CM) technique 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 CM is that if human-induced changes in the state of an ecosystem can be coherently represented by a bunch of attributes, people's choices provide substantial information over their preferences regarding alternative states of the environment.

This paper presents an application of the CM technique to assess potential environmental impacts associated with the construction of a new seaport over the hillside of mount Jaizkibel, a mountainous formation of the third coastal range located in the northwest of the Spanish Cantabrian coast. Jaizkibel is a protected natural resort because of its landscape and geological interest as well as its fauna, flora, and seabed. The CM application permits an *ex-ante* assessment of the environmental costs that this project may bear. It does that by estimating marginal impacts for different environmental attributes useful for coastal management. The paper is organised as follows: Section 2 presents an overview of the CM technique, Section 3 provides a general description of the case study and some details on the survey design, Section 4 reports the main results of the choice experiment, Section 5 discusses the results and, finally, the last section contains some conclusions and suggestions for future research.

2. Methodology: choice modelling technique

CM is a stated preferences method of valuation that converts subjective choice responses into estimated parameters. Choice experiments were first used in marketing research during the 70s in order to analyse consumer choices. Later, this technique was used in transport economics and health economics, and more recently in environmental economics. As mentioned before, the main difference between CVM and CM is that individuals face the valuation of one environmental quality change in the former and several environmental quality changes in the latter. CM confronts individuals with the valuation of various environmental goods (or one good with different attributes) and different levels for these goods or attributes. As a consequence, the researcher obtains marginal values, this is, those resulting from varying in one unit the level of provision of each good or attribute. CM belongs to the family of conjoint analysis methods, defined by Green and Srinivasan [5] 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.” More specifically, choice experiments technique is based on Lancaster’s characteristics theory of value and random utility theory [6].

Following random utility theory, consumers pursue the maximisation of utility in decision-making processes. Thus, if individual i faces m mutually exclusive alternatives, the utility that he or she obtains from alternative j (Uij) can be formalised as follows:

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

where V_{ij} is the observable part of utility (deterministic component), and ε_{ij} is the non-observable part (random component). The utility derived from a given choice will be affected by the attributes of this option, *Z*, as well as from the socioeconomic characteristics of each individual *S*:

$$U_{ij} = V(Z_{ij}, S_i) + \varepsilon_{ij},$$

where V represents the indirect utility function.

Thus, individual *i* will choose alternative j instead of *k* if utility increases, this is, if $U_{ij} > U_{ik}$ for $k \neq j$. However, given the existence of a random component, the above needs to be written in terms of probability, this is, the probability that individual *i* chooses alternative *j* instead of *k* from a finite set of alternatives *C*, would be:

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

In order to estimate the equation above, some hypotheses about the random component's distribution are needed. Stochastic component of utility is usually assumed to be independent and identically (IID) distributed and Gumbel distributed [7]. Thus, the conditional logit model can be written as follows:

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

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 above is estimated by means of a multinomial logit (MNL) regression. 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 (given that both alternatives have a non-zero probability of choice) is unaffected by the presence or absence of any additional alternatives in the choice set" [8].

$$\frac{P_{ij}}{P_{ik}} = \frac{e^{V_{ij}}}{e^{V_{ik}}}$$

As a consequence, IIA depends both on the choice and on the variables included in the specification of V_{ij}, that are assumed to be IID. In case of violation of IIA, the parameters estimation would be biased. The IIA property is usually checked with the test proposed by Hausman and McFadden [9]. Under the null hypothesis, coefficients are not significantly different if the model is estimated including the full set of alternatives f or a subset s:

$$\chi^2 \sim \left(\widehat{\beta}_s - \widehat{\beta}_f\right)' \left[\widehat{V}_s - \widehat{V}_f\right]^{-1} \left(\widehat{\beta}_s - \widehat{\beta}_f\right).$$

However, there are some reasons why IIA or IID hypothesis could be violated, for example, the presence of heterogeneity. If this is the case, a model can be estimated including socioeconomic variables. Other options for relaxing the IIA hypothesis are nested logit models or mixed logit models [10].

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:

$$V_{ij} = \beta_0 + \beta_1 Z_1 + \beta_2 Z_2 + \beta_3 Z_3 + \ldots + \beta_n Z_n + \beta_a S_1 + \beta_b S_2 + \ldots + \beta_m S_j ,$$

where β_0 is the constant term, $\beta_1 \ldots \beta_n$ are the coefficients of environmental attributes Z, and $\beta_a \ldots \beta_m$ are the coefficients of socioeconomic characteristics. 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 [11].

WTP or shadow prices represent the amount of money that one person is willing to give in exchange for an additional amount of the environmental good. Albeit shadow prices do not represent estimations of equivalent variation for use in CBA, they represent estimations ceteris paribus of the value of a marginal change in a given attribute. In order to estimate the total WTP, the interaction between multiple attributes needs 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)*. This welfare measure is theoretically correct as long as individuals are not forced to choose, this is, as long as the status quo option is included in the choice set.

Simplifying the above 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 each attribute’s coefficient by the cost attribute coefficient:

$$WTP = -\frac{\beta_{attribute}}{\beta_{cost}}$$

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

3. Case study: the new port of Pasaia, Spain

3.1. Description of the site

Pasaia, a city located in the Northwest of Spanish Cantabrian coast, near the border between the Basque Country and France, has had maritime and commercial activities in its natural port since the XII and XIII century. Even though, up to the XIX century it was mainly dedicated to ship building and fishing, in the XX century its main activity was the traffic of heavy industry. In recent years, the Port Authority of Pasaia has promoted a project to build a new port in the outside of the bay, under the hills of mount Jaizkibel. Defenders of this project claim that it will be very profitable to the region while opponents argue that the environmental costs of the project advice against its construction.

Jaizkibel is a 2.400 hectares natural site that contains 15 zones declared of high ecological interest by the European Union. The landscape of this area is especially interesting because the mountain goes along the coast with abrupt fall in the western part, with cliffs up to 240 meters high. In these cliffs, geologically highly valuated because of the layout of sandy stratum, lives the *armeria euskadiensis*, an endemic plant of the Basque coast catalogued in extinction danger. In the eastern part, the relief 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, Trichomanes speciosum …)* extremely rare in the rest of Europe. The rest of mount Jaizkibel conforms a non-wooded forest area with some brushes and some pastures associated to local *baserri* (autochthonous farms). Nevertheless, certain spaces maintain its original tree cover, oak grove of *Quercus robur* and *Quercus pyrenaica*. 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, as well as some species of fish and dolphins. 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.

According to a recent study, the construction of a new seaport over Jaizkibel's hillside would provoke some critical impacts [12]: cliffs destruction, loss of vegetable cover, land-use changes, geo-morphological changes, underground hydrological loss, alteration of marine streams, sediment transportation, seabed and local beaches, landscape changes, and air quality worsen.

3.2. Survey design

The aim of this study was to identify and evaluate attributes relevant to preferences over the environmental characteristics of mount Jaizkibel. Attributes and level of provision become critical aspects of any choice experiment given that the only information about preferences provided by respondents are choices between these options [13]. According to Lancaster [14], an environmental attribute can be considered relevant if ignoring it would change our conclusions about consumer's preferences.

The first step in this choice experiment was the correct definition of the change to be valued and the attributes and levels that would be used to construct choice sets. Previous investigation on environmental characteristics of mount Jaizkibel, experts' advice and focus groups facilitated the definition of environmental attributes and levels of provision. Following focus group sessions, a pilot survey using open-ended contingent valuation questions helped to identifying the appropriate levels of cost attribute.

The CE was designed by describing certain changes in the quality of mount Jaizkibel's main attributes. At the beginning, six attributes were identified: landscape, flora, avifauna, seabed, groundwater and air quality. However, last two attributes (groundwater and air quality) were dropped mainly because of their relative little importance as suggested by experts and focus groups, and because there was not sufficient information about predicted changes in the future quality of these attributes.

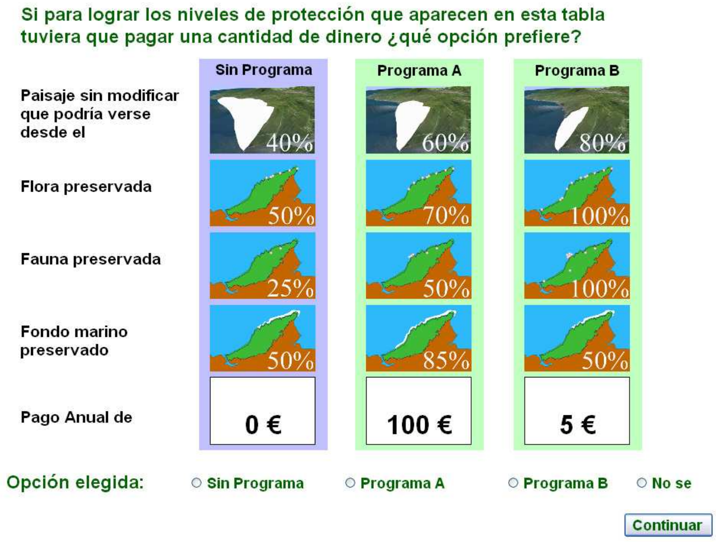
Further in the questionnaire, it was stated that if this mount was not to be protected, these attributes could be affected in the future because of human activities, one of the possible affections being the construction of a seaport, although it was not explicitly mentioned in the questionnaire as a means of environmental degradation. Attributes and levels considered in this study were (see table 1): (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 *armeria euskadiensis*, an endemism of Basque seacoast; (3) avifauna, measured by the future level of protection of today's population of lesser and peregrine falcon; (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 €.

Table 1. Attributes and levels considered

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

Combining all these attributes and levels, near two thousand different combinations were obtained ($4^4 x 7^1$). As it is usually done when the universe of alternatives is very large, statistical design methods were used to simplify the choice sets construction [8]. A main effects fractional factorial design with second order interactions reduced the number of alternatives to 96 pairs of protection alternatives. Given the difficulty that respondents would find in answering all 96 pairwise choice alternatives, they were further grouped in 24 blocks of four choice sets containing two alternative protection programmes. Complexity of the choice task was satisfactorily pre-tested in the focus group. As a consequence, the final version of the questionnaire had four choice sets each formed by the status quo or business as usual option plus two protection alternative programmes (program A and program B) as shown in figure 1.

Fig. 1. Example of protection alternative used in the valuation exercise



The proposed payment vehicle was an annual contribution to a Foundation exclusively dedicated to protecting mount Jaizkibel that all Basque citizens would make. The "don't know" option was included in order to avoid the "yea saying" bias [15]. These answers were eliminated from the data set, assuming that these respondent's preferences were similar to the rest of the sample.

The questionnaire was finally structured in three parts. The first part was devoted to explained the environmental quality change to be valued, this is, it was briefly described the current situation of mount Jaizkibel and some possible future damages to its environmental attributes. The second part (preference elicitation part) contained the choice experiment questions. The last section collected some debriefing and socioeconomic questions.

3.3. Data collection

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 in Spanish, Basque or French, at their choice. The relevant population considered was the population from the Basque Autonomous Community and Navarra in Spain as well as some French cities next to the Spanish border, accounting for 2.5 million people being at least 18 years old. The pilot was conducted in October 2006, while the final survey was undertaken between November and December, 2006. A stratified random sample of 636 individuals was selected from the relevant population. The strata used included age, gender and size of the town of residence, following official statistical information (EUSTAT). In each location, the questionnaires were distributed using random survey routes.

4. Results

In this section, the marginal WTP estimates and the 95% confidence intervals for the attributes are reported. Table 2 contains the fixed parameter logit model estimation. This model was estimated using LIMDEP econometric software. The utility function is assumed to be linear in the parameters and additively separable. The explicative variables included are the attributes described in the previous section: landscape, flora, fauna, seabed and annual payment.

Table 2. Model estimation

Covariate (attribute)	Coefficient	t-Statistic
Landscape	0,02028481	7,38712003
Flora	0,01272370	3,79398566
Avifauna	0,00998106	4,90583083
Seabed	0,00925288	3,90464656
Payment	-0,01462468	-7,17560877
Log-likelihood		-590,4531
Log-likelihood at 0		-627,1635
Observations		687

All the coefficients of the environmental attributes have the expected signs (positive, meaning that protection is more highly valued than loss) and are significant at 1% significance level. The negative coefficient of the price attribute is also expected, indicating that the probability of accepting an annual contribution for protecting mount Jaizkibel's attributes decreases as the price increases.

Hausman and McFadden test was used to test the IIA property [9]. It is tested that the full model (estimated will all three alternative choices) is equivalent to a restricted model where one of the alternatives is eliminated. In either case, the null hypothesis that IIA holds for this data set cannot be rejected, as shown in table 3.

Table 3. IIA/IID tests for the MNL model

Alternative dropped	X2	Degrees of freedom	Probability
Status Quo	6.462	5	0.264
Alternative 1	0.926	5	0.968
Alternative 2	6.560	5	0.255

As shown in the previous section, marginal WTP is calculated as the ratio between the mean coefficients of each environmental attribute and the coefficient of the payment attribute. The following table shows point estimates and 95% confidence intervals of the marginal WTP estimates for the four attributes:

Table 4. Marginal WTP for protecting mount Jaizkibel's environmental attributes, in € per person of 2006

Attribute	Marginal WTP (€/ person-year)	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)

Positive signs of marginal WTP point estimates for the four environmental attributes indicate that the average respondent would be better off with an increase in the level of the attribute. Marginal WTP for one percent improvement in today's quality of Jaizkibel's landscape is estimated at 1.39 euros (2006) per person per year. Similarly, marginal WTP for one percent improvement in the quality of the flora, avifauna and seabed is estimated at 0.87, 0.68 and 0.63 euros per person per year respectively.

95% confidence intervals for point estimates were also constructed in order to incorporate sampling variance into the point estimates adopting the Krinsky-Robb procedure [16]. In this procedure, multiple WTP estimates are produced using random draws from the asymptotic normal distribution of the parameter estimates, as explained by Haab and McConnell [17].

Subsequently, the influence of socio-demographic variables on the WTP was investigated. Table 5 shows different models estimated including significant socio-demographic variables interacting with the payment attribute.

Table 5. Fixed parameter logit models

	Model 1	**Model 2**	**Model 3**	**Model 4**
Attributes				
Payment	-0,01462468	-0,00958240	-0,01739024	-0,02450948
	-7,176	*-4,108*	*-7,356*	*-6,478*
Landscape	0,02028481	0,02058254	0,02011236	0,02018606
	7,387	*7,439*	*7,308*	*7,310*
Flora	0,01272370	0,01297937	0,01284745	0,01297812
	3,794	*3,835*	*3,825*	*3,857*
Avifauna	0,00998106	0,00997069	0,01022194	0,01038877
	4,906	*4,839*	*4,997*	*5,060*
Seabed	0,00925288	0,00912762	0,00944030	0,00914414
	3,905	*3,825*	*3,972*	*3,842*
Interactions attributes-SD				
Payment x Bizkaia		-0,01612752		
		-3,848		
Payment x Identity			0,01079302	
			2,623	
Payment x Mountaineer				0,01409581
				3,386
Model statistics				
Log-Likelihood	-590,4531	-582,1909	-587,0627	-584,1703
Log-Likelihood at 0	-627,1635	-627,1635	-627,1635	-627,1635
LRI	0,05853402	0,07170794	0,06393995	0,06855182
N	687	687	687	687
WTP-Landscape *(at mean values)*	1,3870	1,6691	1,5925	1,5231
WTP-Flora *(at mean values)*	0,8700	1,0525	1,0172	0,9793
WTP-Avifauna *(at mean values)*	0,6825	0,8085	0,8094	0,7839
WTP-Seabed *(at mean values)*	0,6327	0,7402	0,7475	0,6900

Model 1 is the basic model with only attributes. Model 2 deals with the effect of geographical differences. For this purpose, it incorporates WTP according to the territory in which the survey was undertaken. WTP was not significantly different among four of the territories (Gipuzkoa, Navarra, Araba and Iparralde) but it was significantly different for the citizens of Bizkaia. As a consequence, non-Bizkaian citizens' average marginal WTP for protecting, for example, Jaizkibel's landscape was 2.15 euros while Bizkaians' was 0.80 euros. This result is not surprising since Bizkaia is further away from Jaizkibel than the other territories and its use values are lower.

Models 3 and 4 incorporate two socio-demographic characteristics that were found to be significant when interacting with the attribute payment. This is the case for mountaineers and people with Basque cultural identity. On average, a Basque would be WTP 3.05 euros to protect Jaizkibel's landscape while non-Basque would be WTP 1.15 euros. On the other hand, a mountaineer would be WTP on average 1.94 euros for protecting Jaizkibel's landscape while non-mountaineers would be WTP 0.82 euros.

Table 5 also shows that the coefficients for the attributes were very similar in all estimated models and that welfare estimates for the four attributes were not significantly different within the models. This suggests that the WTP estimates used for obtaining compensating surplus measures in the previous section show some robustness.

5. Discussion

The marginal WTP values reported in the previous section correspond to the average maximum WTP (in 2006 euros) that a Basque citizen would be willing to pay annually and indefinitely for a one percent improvement in the attribute level. The positive sign means that the average person would be better off with an increase in the level of the attribute. Therefore, a Basque citizen on average would be better off and willing to pay 1.39 euros for protecting one percent of Jaizkibel's landscape; 0.87 euros for protecting Jaizkibel's flora; 0.68 euros for protecting Jaizkibel's avifauna; and 0.63 for protecting Jaizkibel's seabed.

Estimated welfare measures allowed us also to estimate damages to natural resources in economic terms that could be used in social evaluation tools such as CBA. As an example, three damage scenarios to Jaizkibel's environmental attributes were built, and labelled as Scenario A, based on maximum impacts considered; Scenario B, based on medium impacts considered; and Scenario C, based on minimum impacts considered. Based on these fictitious three scenarios, annual welfare loss is calculated through the compensating surplus equation for a linear additive utility function (no relevant second order interaction was found):

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

Following the above formula, table 6 shows compensating surplus measures for each scenario.

Table 6. Compensating surplus for different degradation scenarios in euros 2006 per person per year

	Level of damage				
Scenario	**Landsc**	**Flora**	**Avifauna**	**Seabed**	**Mean WTP (€/person-year)**
Scenario A	60%	50%	75%	50%	208.74 *(126.26-296.87)*
Scenario B	40%	30%	50%	30%	134.17 *(81.71-190.34)*
Scenario C	20%	15%	25%	15%	67.09 *(40.86-95.17)*

The mean WTP reported in table 6 corresponds to the amount of money, in 2006 values, that one individual would be willing to pay to avoid an environmental damage as described for each scenario. Thus, an average individual would be willing to pay annually 208.74 euros to avoid an environmental damage as described in the high degradation scenario (equivalent to a 60% damage to the landscape, 50% damage to the flora, 75% damage to the avifauna and 50% damage to the seabed), 134.17 euros for the medium degradation scenario (equivalent to a 40% damage to the landscape, 30% damage to the flora, 50% damage to the avifauna and 30% damage to the seabed) and 67.09 euros for the low degradation scenario (equivalent to a 20% damage to the landscape, 15% damage to the flora, 25% damage to the avifauna and 15% damage to the seabed).

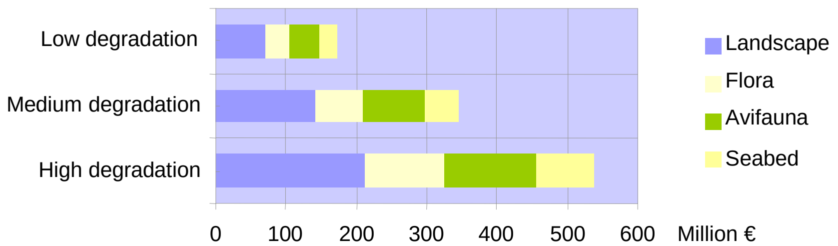
Furthermore, the annual welfare loss associated with the degradation scenarios described above is calculated by multiplying the mean WTP by the relevant population (2.5 million residents), as shown in table 7.

Table 7. Annual welfare loss, in millions of euros, 2006

	Landscape	Flora	Avifauna	Seabed	Annual welfare loss
Scenario A	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)
Scenario B	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)
Scenario C	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)

Annual welfare loss of a deterioration of the environmental quality of mount Jaizkibel may be estimated between 172.11 and 535.52 million euros, depending on the level of future degradation. For example, for Scenario A annual welfare loss is estimated at 535.52 million euros (212.89 million for landscape, 110.60 for flora, 130.76 for avifauna and 81.16 for seabed). For Scenario B, annual welfare loss is estimated at 344.22 million euros (141.96 million for landscape, 66.36 for flora, 87.17 for avifauna and 48.76 for seabed). Finally, for Scenario C, annual welfare loss is estimated at 172.11 million euros (70.96 million for landscape, 33.18 for flora, 43.59 for avifauna and 24.38 for seabed). Figure 2 pictures the annual welfare loss based on these scenarios.

Figure 2. Annual welfare loss based on different scenarios for Jaizkibel



The WTP results seem to be in line with those from similar studies. Given that this study is the first application of the CM technique in the Basque Country, the WTP for protecting a quite general attribute like Jaizkibel's landscape, was compared with SP studies found in the literature. A comparison with other SP results should be treated with caution because there are many reasons why apparently similar applications may entail divergences. Among others, the specific characteristics of the resource valued (i.e.

size, biological interest, specificity of its landscape, etc.), the change to be valued, whether the valuation question is in open or closed format, or the socioeconomic characteristics and structure of preferences of the relevant population may entail significant deviations in the WTP estimates. Santos [18] presents a revision of empirical work for valuing the WTP for preserving rural landscape. Table 8 contains some WTP estimations considered by the author as somehow homogeneous, either because they entail similar policies and populations with different methods or because they entail similar methods with different policies and populations. It also includes a mean estimate of similar studies and the results from a meta-model built upon contingent valuation studies of environmentally sensitive areas.

Table 8. Contingent valuation studies of rural landscape changes

Study	**Landscape change**	**Population**	**CVM method**	**WTP per person and year (€ 2006)**
Santos (1998)	Conserving the Pennine Dales (ESA, England) landscape's attributes	Visitors	DC	78,84 - 96,17
Willis y Garrod (1991)	Conserving the Yorkshire Dales (UK) today's landscape	Visitors	DC (adjusted)	59,89 - 89,43
Santos (1997)	Conserving today's agricultural landscapes in the Peneda-Geres (NP, Portugal)	Visitors	DC	64,83 - 75,72
Santos (2007)	Multiple study average		DC	42,40 - 64,56
Santos (2007)	Meta-analytical model predictions based on similar studies		DC	48,16 - 97,96

Source: [18], prices adjusted to euros 2006.[1]

In the selected studies, WTP ranges from 42.40 € to 97.96 € per person and year. These estimates are slighly higher that the WTP for protecting the mount Jaizkibel today's landscape (between 27.80 y 83.40 € per person and year depending on the degradation scenario considered). This difference may be explained, among other things, because the population surveyed in these studies were visitors (with usually higher WTP than non-visitors) while in our application the whole population was surveyed.

[1] WTP estimates, in pounds per household in 1995, were converted into euros 2006 taking into account the average size of English households (2,41), price changes in England between 1995 and 2006 (119,82), average exchange rate pound-euro in 2006 (1,46725) and differences in purchasing power capacity between England and the Basque Country in 2006 (117,5/125,6).

6. Conclusions

As Willis, Garrod and Harvey [3] point out: "cost-benefit analysis exists to aid welfare optimization, by incorporating the strength of preferences of the public which are not reflected through appropriate market mechanisms." If relevant environmental costs are not incorporated in CBA of coastal developmental projects, welfare measures will be probably upward bias while environmental impacts will be either ignored or dismissed. Bearing in mind the limitations that CBA has at incorporating environmental costs, it can be still considered a useful input for environmental decision-making [19, 20].

This paper examines the social welfare loss that encompasses the construction of a new seaport to the environmental quality of mount Jaizkibel, a mountainous formation located in the Northwest of Spanish Cantabrian coast. For this purpose, CM is proposed as an efficient means for estimating economic values useful in cost-benefit analysis of transport infrastructures: firstly, because it permits ex-ante assessment of environmental costs and, secondly, because it is capable of estimating marginal impacts. We have also shown how these results can be used for incorporating environmental costs in CBA.

Marginal WTP for the conservation of Jaizkibel's environmental attributes (landscape, flora, avifauna and seabed) represents the annual social welfare loss for each individual associated with the deterioration of one percent in an environmental attributes. In 2006 values, an average individual would be willing to pay annually 1.39 euros for avoiding one percent deterioration of mount Jaizkibel today's landscape; 0.87 euros for avoiding one percent deterioration of today's flora; 0.68 euros for avoiding one percent deterioration of today's avifauna; and 0.63 euros for avoiding one percent deterioration of today's seabed. It has also been shown how these estimates vary according to some sociodemographic characteristics of the respondents (territory, identity and mountaineer).

Finally, the estimated economic value of preserving Jaizkibel natural area as it is today was estimated between 172.11 and 535.52 million euros per annum. This value depends on the future environmental damage that may cause the construction of a new seaport. If the degradation caused by the port is equivalent to that described in Scenario A, the social welfare loss was estimated in 535.52 million euros per annum. If the degradation caused by the port is equivalent to that described in Scenario B, the social welfare loss is estimated in 344.22 million euros per annum. Finally, if the degradation caused by the port is equivalent to that described in Scenario C, the social welfare loss is estimated in 172.11 million euros per annum.

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