Using a Choice Experiment to Account for Preference Heterogeneity in Wetland Attributes: The case of Cheimaditida wetland in Greece[*]

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Abstract

Despite being amongst the Earth's most productive ecosystems, wetlands have been degraded and lost at an unprecedented rate globally, especially throughout the last century. In recognition of the importance of the crucial ecological functions and economic benefits they provide, international efforts such as the Ramsar Convention (1996), and European Union level efforts such as the Water Framework Directive (2000/60/EC), are now in place to ensure conservation, sustainable management and improvement of the remaining wetlands. This paper aims to assist policy makers in formulating efficient, effective and sustainable wetland conservation and management policies by providing them with the results of a valuation exercise using the Cheimaditida wetland in Greece as a case study. A choice experiment is employed to estimate the benefits of the non-use values of the Cheimaditida wetland that accrue to the Greek public and to investigate heterogeneity in their preferences. Results from this choice experiment reveal that there is considerable preference heterogeneity across the public, and that they attach positive and significant values for the sustainable management of this wetland. These results can be weighed against the costs of alternative wetland management scenarios in order to carry out a cost benefit analysis. Thus they can aid in the design of socially optimal policies for conservation and sustainable management of the Cheimaditida wetland, with implications for other wetlands in Greece and the rest of Europe.

Keywords: Choice experiment, non-use values, wetlands, conditional logit model, random parameter logit model, interactions.

JEL classifications: Q25, Q51, Q53, Q57

1. Introduction and Motivation

Wetlands are amongst the Earth's most productive ecosystems, providing a diverse array of important ecological functions and services, ranging from flood and flow control to groundwater recharge and discharge, water quality maintenance, habitat and nursery for plant and animal species, biodiversity, carbon sequestration, and other life-support functions. These ecological functions and services translate directly into economic functions and services such as flood protection, water supply, improved water quality, commercial and recreational fishing and hunting, and the mitigation of global climate change (Barbier *et al.*, 1997; Woodward and Wui, 2001; Brouwer *et al*, 2003; Brander *et al.*, 2004).

Historically, many wetlands have been treated as wastelands and drained or otherwise degraded (Barbier *et al.*, 1997). To this day, they are under increasing pressure from anthropogenic activities, including conversion of wetlands to intensive agricultural use and to other industrial and residential uses; their drainage as a result of excessive irrigation in agriculture; pollution as a result of nutrient run-off from intensive agricultural production, and industry. Other factors considered to affect the management of wetlands include poverty and economic inequality, pressure from population growth, immigration and mass tourism, and social and cultural conflicts (Skourtos *et al.*, 2003).

Though the amount of wetland area lost is difficult to quantify since the total area of wetlands in the world is uncertain, there are some figures for individual countries indicating the scale of the problem. In Europe, 50-60 percent of wetlands have been lost in the past century while during the same period, the United States lost 54 percent of its original wetlands (MEDWET, 1996; Barbier *et al.*, 1997). Alarmed by the accelerated rate of wetland loss and degradation, in 1971 100 countries created the Ramsar Convention on Wetlands of International Importance, providing the framework for national action and international cooperation for the 'conservation and wise use' of wetlands and their resources (Ramsar, 1996).

In addition to this international effort, there are also European Union (EU) level policies which assert that there should be no further wetland loss or degradation. The EU Water Framework Directive (WFD) (2000/60/EC) clearly identifies the protection, restoration and enhancement of the water needs of wetlands as part of its purpose and stresses the EU's involvement in wetland protection and enhancement and its commitment in setting up strategic policies for these purposes. Further to the WFD, there are other EU level regulations, such as the EU Birds Directive (79/409/EEC) and the EU Habitats Directive (92/43/EEC), which aim to conserve several ecological functions, services and attributes that are provided by wetlands.

The case study in this paper is the Cheimaditida wetland in Greece, which contains one of the few remaining freshwater lakes in the country and provides several of the important ecological functions described above. Greece has lost 63 percent of its wetlands between 1920 and 1991 (Barbier *et al.*, 1997) and, as a signatory to the Ramsar convention and an EU member state, it is obliged to conserve, sustainably manage and improve the conditions of its remaining wetlands. The aim of this study is to provide policy-makers with much needed information on the public benefits generated by the wetland in terms of non-use values that accrue to the Greek public[1]. To accomplish this, the non-use values of the Cheimaditida wetland are estimated by using a recently developed non-market valuation technique, namely a choice experiment (CE) method. A non-market valuation technique must be used to determine the value of wetland benefits since most of the outputs, functions and services that wetlands generate are not traded in the markets. The CE method is adopted because, within the range of non-market valuation techniques, this method is most appropriate for capturing the benefits generated by the multiple services and functions of wetlands. Furthermore, the CE method enables estimation of the value of the environmental asset as a whole, as well as the implicit values of its attributes (Hanley *et al.*, 1998; Bateman *et al.*, 2003).

The private benefits generated by the direct and indirect use values of the Cheimaditida wetland that accrue to the local population have been estimated by Psychoudakis *et al.* (2004). The study presented here investigates the non-use values of the wetland as they accrue to the wider Greek public. To estimate these non-use

[1] Non-use values refer to the values of the benefits generated by environmental goods and services that are unrelated to the value of their current or planned use. Non-use values are composed of existence value, bequest value and altruistic value. Existence value is the value of knowing that the environmental good exists even if no one in this generation or in the future generations intend to use it. Bequest value refers to the value of knowing that future generations will benefit from the environmental good, and altruistic value is the value of knowing that other individuals in this generation benefit from the environmental good (Bateman *et al.,* 2003).

values, 407 choice experiment surveys were administered in 10 cities and towns in Greece. The results reveal that the Greek public derive positive and significant benefits from several non-use values of the wetland including biodiversity, open water surface area, research and educational extraction from the wetland, and locals employed in environmentally friendly occupations. These estimated benefit values are then used in a cost-benefit analysis of alternative wetland management scenarios, in order to determine the scenario that maximises social welfare.

The paper unfolds as follows: The next section presents a brief summary of previous wetland valuation studies. The third section describes the theoretical background of the choice experiment method while section 4 describes the Cheimathitida case study site. Section 5 describes the choice experiment design and administration. The results of the econometric analysis and of the cost-benefit analysis are reported in section 6, and section 7 concludes with a discussion of the results and policy implications.

2. Previous Applications

Increasing recognition of the importance of wetlands is reflected by the growing number of valuation studies on this subject. Heimlich *et al.* (1998), Kazmierczak (2001), and Boyer and Polasky (2004) provide an extensive overview of wetland valuation studies which include a broad variety of valuation techniques, such as the contingent valuation, hedonic price, replacement value, damage avoided and production value method. Given the large number of wetland valuation studies that are now available, three meta-analysis studies have also been conducted. Woodward and Wui (2001) use 39 wetland valuation studies and find an average value of about US$915 (€760) per acre of wetland. Brouwer *et al.* (2003) use 30 contingent valuation studies and find the mean value of wetlands to be 62SDR (special drawing rights) (€74) with a median of 34SDR (€40) per household per annum. Finally, Brander *et al.* (2004) use 80 studies and find that average annual wetland value is US$2,800 (€2,300) per hectare per annum, with a median of US$150 (€125) per hectare per annum

Of the wetland valuation studies reviewed, only three are specific to Greece. Kontogianni *et al.* (2001) conduct a contingent valuation survey to evaluate different stakeholders preferences of four development / conservation scenarios for the wetland surrounding the Kalloni Bay on the island of Lesvos, Greece, and find mean WTP values ranging from 6054 to 10,041Gdr (€17.8 to €29.5) every 3 months for 2 years depending on the scenario. Oglethorpe and Miliadou (2000) use contingent valuation to estimate the use and non-use values of Lake Kerkini in Northern Greece and find that the mean annual WTP is 6906Gdr (€20.3) of which 96 per cent is attributed to non-use values. Psychoudakis *et at.* (2005) estimate use values of the Zazari-Cheimathidita wetland functions and find mean annual WTP ranging from €40.15 for food web support to €44.43 for nutrient export. To our knowledge the study presented here is the first application of a choice experiment to wetland valuation in Greece.

There are to date only three CE applications that estimate the non-use values of wetland functions and services. The first is that of Morrison *et al.* (1999) who investigate the non-use values of Macquarie Marshes wetland in Australia. The second application is that of Carlsson *et al.* (2003), who estimate both use and non-use values of the Staffanstorp wetland in Sweden. The final one is by Othman *et al.* (2004) who employ the CE method to estimate the non-use values of the Matang Mangrove Wetlands in Perak State in Malaysia. The choice experiment on the Cheimaditida wetland presented here provides a valuable addition to this scant literature.

3. Choice Experiment Method

The CE method is a ‘highly structured method of data generation’ (Hanley *et al.*, 1998), relying on carefully designed tasks or ‘experiments’ to reveal the factors that influence choice. The environmental resource is defined in terms of its attributes and their levels in different states of the world (e.g., with and without sustainable management of the resource). One of the attributes is a monetary one, which enables estimation of the value of the other attributes in terms of respondents’ willingness to pay (WTP). Experimental design theory is used to construct profiles of the resource in terms of its attributes and their levels. Two or three alternative profiles are then assembled in choice sets and presented to respondents, who are asked to state their preferred profile in each choice set. This method enables estimation not only of the value of the environmental resource as a whole, but also of the implicit value of its attributes, their implied ranking and the value of changing more than one attribute at once (Hanley *et al.*, 1998; Bateman *et al.*, 2003).

The CE method has its theoretical grounding in Lancaster's model of consumer choice (Lancaster, 1966), and its econometric basis in random utility theory (Luce, 1959; McFadden, 1974). Lancaster proposed that consumers derive satisfaction not from goods themselves but from the attributes they provide. To illustrate the basic model behind the CE presented here, consider a respondent's choice for a wetland management scenario and assume that utility depends on choices made from a set C, i.e., a choice set, which includes all the possible wetland management scenario alternatives. The respondent is assumed to have a utility function of the form

$$U_{ij} = V(Z_j, S_i) + e(Z_j, S_i) \tag{1}$$

where for any respondent *i*, a given level of utility will be associated with any wetland management scenario alternative *j*. Utility derived from any of the wetland management scenario alternatives depends on the attributes of the wetland management scenario (Z_j) and the social, economic and attitudinal characteristics of the respondent (S_i). The random utility theory (RUT) is the theoretical basis for integrating behaviour with economic valuation in the CE method. According to RUT, the utility of a choice is comprised of a deterministic component (V) and an error component (e), which is independent of the deterministic part and follows a predetermined distribution. This error component implies that predictions cannot be made with certainty. Choices made between alternatives will be a function of the probability that the utility associated with a particular option j is higher than those for other alternatives. Assuming that the relationship between utility and attributes is linear in the parameters and variables function, and that the error terms are identically and independently distributed with a Weibull distribution, the probability of any particular alternative j being chosen can be expressed in terms of a logistic distribution. Equation (1) can be estimated with a conditional logit (CL) model (McFadden 1974; Greene 1997 pp. 913-914; Maddala 1999, pp. 42), which takes the general form

$$P_{ij} = \frac{\exp(V(Z_{ij}, S_i))}{\sum_{h \in C} \exp(V(Z_{ih}, S_i))} \tag{2}$$

where the conditional indirect utility function generally estimated is

$$V_{ij} = \beta + \beta_1 Z_1 + \beta_2 Z_2 + ... + \beta_n Z_n + \delta_1 S_1 + \delta_2 S_2 + ... + \delta_l S_m \quad (3)$$

where β is the alternative specific constant (ASC) which captures the effects on utility of any attributes not included in choice specific attributes. The number of wetland management scenario attributes considered is *n* and the number of social, economic and attitudinal characteristics of the respondent employed to explain the choice of the wetland management scenario is *m*. The vectors of coefficients β_1 to β_n and δ_1 to δ_l are attached to the vector of attributes (*Z*) and to the vector of interaction terms (*S*) that influence utility, respectively. Since social, economic and attitudinal characteristics are constant across choice occasions for any given respondent, these only enter as interaction terms with the wetland management scenario attributes.

The assumptions about the distributions of error terms implicit in the use of the CL model impose a particular condition known as the independence of irrelevant alternatives (IIA) property. This property states that the probability of a particular alternative being chosen is independent of other alternatives. Whether the IIA property holds can be tested by dropping an alternative from the choice set and comparing parameter vectors for significant differences. If the IIA property is violated then CL results will be biased and hence a discrete choice model that does not require the IIA property, such as random parameter logit (RPL) model, should be used. Inclusion of social, economic and attitudinal characteristics is also beneficial in avoiding IIA violations, since these are relevant to preferences of the respondents and can increase the deterministic component of utility while decreasing the error one (Rolfe *et al.*, 2000; Bateman *et al.*, 2003).

Though the use of social, economic and attitudinal characteristics help to recognise conditional, observed heterogeneity, these methods do not detect for unobserved heterogeneity. It has been demonstrated that heterogeneity can be present in significant residual form even when conditional heterogeneity is accounted for (Garrod *et al.*, 2002). Unobserved heterogeneity in preferences across respondents can be accounted for in the RPL model. The random utility function in the RPL model is given by

$$U_{ij} = V(Z_j(\beta + \eta_i), S_i) + e(Z_j, S_i) \tag{4}$$

Similarly to the CL model, utility is decomposed into a deterministic component (*V*) and an error component stochastic term (*e*). Indirect utility is assumed to be a function of the choice attributes (Z_j) with parameters β, which due to preference heterogeneity may vary across respondents by a random component η_i, and of the social, economic and attitudinal characteristics (S_i) if included in the model. By specifying the distribution of the error terms *e* and η, the probability of choosing *j* in each of the choice sets can be derived (Train, 1998). By accounting for unobserved heterogeneity, equation (2) now becomes

$$P_{ij} = \frac{\exp(V(Z_j(\beta + \eta_i), S_i))}{\sum_{h \in C} \exp(V(Z_h(\beta + \eta_i), S_i))} \tag{5}$$

Since this model is not restricted by the IIA assumption, the stochastic part of utility may be correlated among alternatives and across the sequence of choices via the common influence of η_i. Treating preference parameters as random variables requires estimation by simulated maximum likelihood. Procedurally, the maximum likelihood algorithm searches for a solution by simulating *m* draws from distributions with given means and standard deviations. Probabilities are calculated by integrating the joint simulated distribution.

Recent applications of the RPL model have shown that this model is superior to the CL model in terms of overall fit and welfare estimates (Breffle and Morey, 2000; Layton and Brown, 2000; Carlsson *et al.*, 2003; Kontoleon, 2003; Lusk *et al.*, 2003; Morey and Rossmann, 2003). It should also be noted however that even if unobserved heterogeneity can be accounted for in the RPL model, the model fails to explain the sources of heterogeneity (Boxall and Adamowicz, 1999). One solution to detecting the sources of heterogeneity while accounting for unobserved heterogeneity is by including respondent characteristics in the utility function as interaction terms. This enables the RPL model to pick up preference variation in terms of both unconditional taste heterogeneity (random heterogeneity) and individual characteristics (conditional heterogeneity), and hence improve model fit (e.g., Revelt and Train, 1998; Morey and Rossmann, 2003).

The CE method is consistent with utility maximisation and demand theory (Bateman *et al.*, 2003). When parameter estimates are obtained, welfare measures can be estimated using the following formula:

$$WTP = \frac{\ln \sum_k \exp(V_k^1) - \ln \sum_k \exp(V_k^0)}{\alpha} \qquad (6)$$

where WTP is the welfare measure, α is the marginal utility of income (generally represented by the coefficient of the monetary attribute in the CE), and V_k^0 and V_k^1 represent indirect utility functions before and after the change under consideration. For the linear utility index the marginal value of change in a single attribute can be represented as a ratio of coefficients, reducing equation (6) to

$$WTP = -1\left(\frac{\beta_{attribute}}{\beta_{monetary\ variable}}\right) \qquad (7)$$

This part-worth (or implicit price) formula represents the marginal rate of substitution between income and the attribute in question, i.e., the marginal WTP for a change in any of the attributes. Compensating surplus welfare measures can be obtained for different wetland management scenarios associated with multiple changes in attributes, i.e., equation (7) simplifies to

$$Compensating\ surplus = -(V^0 - V^1)/\beta_{monetary\ variable} \qquad (8)$$

4. Cheimaditida Wetland Case Study

The case study in this paper is the Cheimaditida wetland, located 40 km Southeast of Florina in Northwest Greece. This wetland includes Lake Cheimaditida, one of the few remaining freshwater lakes in Greece, and constitutes a total wetland area of 168 km^2 surrounded by extensive marshes with reeds (*Phragmites sp.*). The wetland is rich in flora, fauna and habitat diversity. It supports six habitat types listed under

Annex I of the EU Habitats Directive (92/43/EEC), one of which is a *priority natural habitat* under Article 1, namely habitat type 7210 Calcareous fens with *Cladium mariscus* and *Carex davalliana*. Of the 150 relatively rare plant species in the wetland, 8 are Balkan endemic, 12 are only found in the Mediterranean Region and 6 are listed under the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES). The wetland also supports a wide array of fauna diversity, including 11 mammals, 7 amphibians, 7 reptiles and 8 fish, most of which are listed under Annex II and IV of the EU Habitats Directive (92/43/EEC). Further, the Cheimaditida wetland is recognised as an 'Important Bird Area' with approximately 140 identified bird species. Most of these are under protection, including the globally threatened species Dalmatian pelican (*Pelecanus crispus*), Ferruginous duck (*Aythya nyroca*) and the lesser kestrel (*Falco naumanni*) (M. Seferlis, personal communication, 2004).

Within the wetland the main economic activities include agriculture, forestry and fishing. Agriculture is a vital activity where alpha-alpha and maize are the main cash crops whose production is water and fertiliser intensive. Water extraction from the lake for irrigation in agriculture, and pollution due to run-off from agricultural production, have adverse effects on water quantity and quality. These in turn affect the level of biodiversity that the wetland is able to support. Current local employment in agriculture supported by the wetland is estimated at 1470. This is expected to fall as declining quality and quantity of water will no longer be able to support the current number of locals (M. Seferlis, personal communication, 2004; Psychoudakis *et al.*, 2005).

5. Choice Experiment Design and Application

5.1. Choice Experiment Design

The first step in CE design is to define the good to be valued in terms of its attributes and their levels. The good to be valued in this CE study is the wetland management scenario. Experimental levels of four wetland management attributes were identified in consultation with ecologists and hydrologists at the Greek Centre for Biotopes and Wetlands (EKBY) and agricultural and environmental economists at the Aristotle University of Thessaloniki, following an extensive literature review of the existing valuation studies on non-use values of wetlands, and the specific issues pertaining to the Cheimaditida wetland. Finally, three focus groups were conducted to determine the final attributes and their levels that are important to the Greek public, as well as the vocabulary and language to be used in the CE.

The selected attributes and their levels are reported in Table 1. Non-use values may be derived from environmental factors, as well as economic and social factors (Portney, 1994; Morrison *et al.,* 1999; Bergmann *et al*., 2005). Therefore two environmental and two economic and social attributes were selected to reflect non-use values generated by the wetland. The former are biodiversity and open water surface area, and the latter are the inherent research and educational values that can be extracted from the wetland, and the values associated with environmentally friendly employment opportunities. Many species of animals, plants and their habitats depend on wetlands for their continued existence. To date the majority of the non-use values associated with wetlands that have been estimated have been attributed to biodiversity[2]. Open water surface area and the natural vistas associated with them are expected to create non-use values through feelings of serenity and tranquillity. Further, higher open water surface areas provide water quantity required for sustaining the wetland's biodiversity. Research and educational extraction from the wetland is expected to contribute to non-use values associated with cultural heritage and scientific knowledge. Finally, re-training of locals in environmentally friendly occupations are expected to generate non-use values to the wider public.

A further underlying criteria in the selection of the attributes was that each was directly associated with a separate and distinct management strategy, required for cost benefit analysis (CBA). Improving the existing biodiversity level to a high status requires management strategies targeted towards water quality and quantity (e.g., switching to water saving technologies, construction of a dyke); the enlargement of the open water surface area entails interventions to create water corridors through the existing reef beds; the research and educational attribute can be enhanced by the provision of facilities (e.g., visitor centre, books, microscopes); and the non-use values of employment can be supported by re-training locals to alter their agricultural management practices into more environmentally friendly occupations such as arid-crop production.

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[2] See Brouwer *et al.* (2003) and Brander *et. al*. (2004) for a list of valuation studies that have estimated the non-use values of biodiversity in wetlands.

The fifth attribute included in the CE is a monetary one, which is required to estimate welfare changes. The levels of the monetary attribute used in this CE were determined through an open-ended pilot contingent valuation survey (Birol, Karousakis and Koundouri, forthcoming). The payment levels used in the CE are €3, €10, €40 and €80.

[Table 1]

A large number of unique wetland management scenarios can be constructed from this number of attributes and levels[3]. An orthogonalisation procedure is used to recover only the main effects, consisting of 32 pair wise comparisons of alternative wetland management scenarios. These are randomly blocked to 4 different versions, each with 8 choice sets. An example of a choice set is presented in Figure 1.

[Figure 1]

5.2. Choice Experiment Data Collection

The CE survey was administered in February and March of 2005 with face-to-face interviews. The survey design consisted of two stages. In the first stage 8 towns (Amyntaio, Ptolemaida, Florina, Edessa, Kozani, Veroia, Naoussa, Chalkithona) and two cities (Athens and Thessaloniki), were selected. These locations were chosen so as to represent a continuum of distances from the Cheimaditida wetland, as well as rural and urban population. This design encompasses 60 percent of the Greek population, with a sampling frame of 6 409 000. This stratified design enables testing of the hypotheses about the impacts of the respondents' social, economic and attitudinal characteristics and location on their valuation of non-use attributes of the Cheimaditida wetland.

In the second stage, randomly selected individuals were surveyed in each of the city/town centres. The CE survey was administered to be representative of the Greek population in terms of gender and age, and only individuals aged 18 years or older were surveyed. During the interviews a map of the wetland location and colour photographs were shown to each respondent. Enumerators described the Cheimaditida wetland, its location, ecological importance and threats to its existence, and reminded the respondents of their budget constraints and of alternative wetlands and other environmental goods in Greece. Finally, the enumerators also explained that the attributes of the wetland management scenarios were selected as a result of prior

[3] The number of wetland management scenarios that can be generated from 5 attributes, 2 with 4 levels and the remaining 3 with 2 levels, is $4^2 * 2^3 = 128$.

research and were combined artificially, and each attribute was defined to ensure uniformity in understanding. The total sample size consists of 407 respondents and was distributed between the 10 locations approximately proportionately to their population levels.

In addition to the CE questions, data on the respondents' social and economic characteristics, and environmental attitudes were collected. This information is required so as to assess the representativeness of the sample of the Greek public, as well as to use these data as explanatory variables to investigate variation in valuation. The descriptive statistics of the sample are presented in Table 2.

[Table 2]

The social and economic characteristics of the sample are similar to those of the Greek population with the exception of income, the percentage of respondents with children, and education. The former is partly due to the fact that incomes in Athens and Thessaloniki are significantly higher than the Greek average. With respect to the percentage of respondents with children, the sample average is lower because a large proportion of the respondents were students, which also explains the high proportion of respondents with university degrees and above.

The attitudes of the respondents for environmental issues were elicited through a series of questions on their purchase of organic produce, environmental publications, fair-trade and environmentally friendly products, and recycling. These were measured on a Likert-scale ranging from zero (never) to 4 (always). Respondents were also asked whether they are a member of an environmental group. An environmental consciousness index (ECI), ranging from 0 to 20, was calculated using the Likert scores and environmental group membership.

6. Results

The data were coded according to the levels of the attributes. Attributes with two levels (i.e., biodiversity, open water surface area, and research and education extraction) entered the utility function as binary variables that were effects coded. For biodiversity, high level was coded as 1 and low level was coded as –1. For open water surface area, high level was 1 and the low level was –1. Similarly, 1 was entered for high levels of research and educational extraction, and –1 for low levels. The levels for the number of locally employed farmers that would be re-trained were entered in cardinal-linear form and consequently took the levels of 30, 50, 75, and 150. Similarly, the payment attribute was coded as 3, 10, 40, and 80.

The attributes for the ‘neither management scenario’ option were coded with zero values for each of the attributes. The alternative specific constants (ASC) were equal to 1 when either management scenario A or B was selected, and to 0 when the ‘neither management scenario’ option was selected. The choice data were then converted from wide format to long format with a program coded in LIMDEP 8.0 NLOGIT 3.0 This data conversion step is necessary to estimate models with multiple responses from each respondent (i.e., a format similar to panel data).

6.1.Conditional Logit Model

The CE was designed with the assumption that the observable utility function would follow a strictly additive form. The model was specified so that the probability of selecting a particular wetland management scenario was a function of attributes of that scenario and of the ASC. Using the 3256 choices elicited from 407 respondents, four conditional logit (CL) models with logarithmic and linear specifications for the attributes with four levels were estimated and compared using LIMDEP 8.0 NLOGIT 3.0. The highest value of the log-likelihood function was found for the specification with both four-levelled attributes in linear form. The results of the CL estimates for the sample are reported in the first column of Table 3.

Although the overall fit of the model, as measured by McFadden’s ρ^2, is low by conventional standards used to describe probabilistic discrete choice models[4] (Ben-Akiva and Lerman, 1985), the coefficients are highly significant at less than 1% level and all the signs are as expected *a priori*. All of the wetland management attributes are significant factors in the choice of wetland management scenario, and *ceteris paribus* any single attribute increases the probability that a management scenario is selected. In other words, the respondents value wetland management scenarios which result in more biodiversity, larger open water surface area, more research and education opportunities and more locals re-trained in environmentally friendly occupations. The sign of the payment coefficient indicates that the effect on utility of

[4] The ρ^2 value in multinomial logit models is similar to R^2 in conventional analysis, except that significance occurs at lower levels. Hensher and Johnson (1981) comment that values of ρ^2 between 0.2 and 0.4 are considered to be extremely good fits.

choosing a choice set with a higher payment level is negative. When the payment attribute is used as the normalising variable, the most important wetland management attribute is the management of biodiversity in the wetland. This is followed by open water surface area and research and educational extraction from the wetland, both of which are similar, and finally by the re-training of locals attribute (per person). The significance of this social attribute reveals that the public cares about local rural employment, as found by Morrison *et al.* (1999) and Colombo *et al.* (2005). Overall, these results indicate that positive and significant non-use values exist for environmental, economic and social attributes of the wetland. The positive sign on the ASC coefficient implies that a positive utility impact occurs in any move away from the status quo.

[Table 3]

As explained in Section 3, the assumptions about the distributions of error terms implicit in the use of the CL model impose a particular condition known as the independence of irrelevant alternatives (IIA) property. This property states that the relative probabilities of two options being chosen are unaffected by introduction or removal of other alternatives. To test whether the CL model is appropriate, the Hausman and McFadden (1984) test for the IIA property is used. The IIA test involves constructing a likelihood ratio test around the different versions of the model where the choice alternatives are excluded. If IIA holds then the model estimated on all choices should be the same as that estimated for a sub-set of alternatives. The results of the test are shown in table 4 below, indicating that IIA property cannot be rejected at the 99% level. Therefore the CL model is the appropriate model for estimation of this data.

[Table 4]

6.2.Random Parameter Logit Model

Even though the CL model does not violate the IIA property, it assumes homogeneous preferences across respondents. Preferences however are in fact heterogeneous and accounting for this heterogeneity enables estimation of unbiased estimates of individual preferences and enhances the accuracy and reliability of estimates of demand, participation, marginal and total welfare (Greene, 1997). Furthermore, accounting for heterogeneity enables prescription of policies that take equity concerns into account. An understanding of who will be affected by a policy change in addition to understanding the aggregate economic value associated with such changes is necessary (Adamowicz and Boxall, 2001). The random parameter logit (RPL) model, which accounts for unobserved, unconditional heterogeneity, should be used in order to account for preference heterogeneity in pure public goods (Kontoleon, 2003), such as the wetland studied in this CE.

The RPL model is estimated using LIMDEP 8.0 NLOGIT 3.0. All the parameters except the payment attribute were specified to be normally distributed (Train, 1998; Revelt and Train, 1998; Morey and Rossmann, 2003; Carlsson *et al.*, 2003), and distribution simulations were based on 500 draws. The results of the RPL estimations are reported in the second column of Table 3. RPL model estimates of the sample result in significant derived standard deviations for the ASC and three attributes (open water surface area, research and education, and retraining) indicating that the data supports choice specific unconditional unobserved heterogeneity for these attributes. The log likelihood ratio test rejects the null hypothesis that the regression parameters are equal at 0.5% significance level. Hence improvement in the model fit can be achieved with the use of the RPL model. On the basis of this test it can be concluded that the RPL model is appropriate for analysis of the data set presented in this paper.

6.3.Random Parameter Logit Model with Interactions

As discussed in Section 3, even if unobserved heterogeneity is accounted for with the RPL model, the model fails to account for observed, conditional heterogeneity. One solution to detecting the sources of heterogeneity while accounting for unobserved heterogeneity is by including respondent characteristics in the utility function as interaction terms. Interaction of respondent-specific social, economic and attitudinal characteristics with choice specific attributes or with ASC of the indirect utility function is a common solution to dealing with the heterogeneity problem as well as with violations of the IIA (e.g., Rolfe *et al.*, 2001). Use of the RPL model with interactions enables the identification of preference variation in terms of both unconditional taste heterogeneity (random heterogeneity) and conditional heterogeneity, thereby improving the model fit (e.g., Revelt and Train, 1998; Morey and Rossmann, 2003; Kontoleon, 2003).

After extensive testing with the social, economic and attitudinal characteristics that were collected in the survey, the model that includes age, age square, education, income, children, ECI and distance interacted with the payment attribute was found to fit the data the best. The indirect utility function is extended to include these interactions and the RPL model with interactions was estimated using LIMDEP 8.0 NLOGIT 3.0. The results are reported in the final column of Table 3. This model has a higher overall fit compared to the CL and RPL model, with a ρ^2 of 0.1214. The log likelihood ratio test rejects the null hypothesis that the regression parameters for the RPL model and the RPL model with interactions are equal at 0.5% significance level. Therefore improvement in the model fit can be achieved with the use of social, economic and attitudinal characteristics in the RPL model. Similar to the RPL model estimated above, the RPL model with interactions also results in significant derived standard deviations for the ASC and three attributes (open water surface area, research and education, and retraining) indicating that data supports choice specific unconditional unobserved heterogeneity for these attributes.

The interactions between payment and age, education, income, ECI and distance are positive and significant. Confirming the results of several environmental valuation studies, older respondents and those with higher levels of environmental consciousness, income and university degrees are likely to have a higher WTP for wetland management scenarios. The positive interactions between payment and distance to the wetland are contrary to the 'decay factor' found by Bateman *et al.* (1995), however this may be explained by the fact the two locations with the furthest distances to the site are the two largest and wealthiest cities in Greece (i.e., Athens and Thessaloniki). The interaction between age square and payment is negative, indicating that much older respondents are willing to pay less for wetland management, as found by Carlsson *et al.* (2003). Finally, the interaction between the dummy for having a child and payment attribute is negative. Even though several other valuation studies have shown that having children has a positive influence on the respondents' WTP (e.g., Kosz, 1996) due to the 'bequest motives' that people might have over wanting to preserve the environment for their future heirs to enjoy (Krutilla, 1967), this result may be explained by the fact that having children impose constraints on the respondents' budget.

6.4. Estimation of Willingness To Pay

Table 5 reports the implicit prices, or marginal WTP values, for the each of the wetland management attributes with the respective 95% confidence intervals, calculated using equation (6) in Section 3 and the Wald procedure. For comparisons, estimates were calculated using all three models. The results show that the WTP estimates from the three models differ significantly, however the ranking of attributes remains consistent. The RPL model with interactions gives the highest marginal WTP estimates whereas the CL model gives the lowest marginal WTP estimates (with the exception of the biodiversity attribute). Therefore, in addition to its ability to account for the strong observed and unobserved heterogeneity in preferences, the RPL model with interactions also results in higher WTP estimates.

Based on the model that fits the data the best, i.e., the RPL model with interactions (estimated at the sample averages of the characteristics), respondents are WTP 32 cents for an extra local re-trained in environmentally friendly employment. This can be compared with the value found in Colombo *et al.* (2005) of 10 cents for rural job creation in southern Spain and in Bergmann *et al.* (forthcoming) of 81 cents for employment creation in renewable energy in rural Scotland. Respondents' average WTP for high levels of biodiversity is €36.68, which is comparable to the values found by Colombo *et al.* (2005) (€17.77 for high level of biodiversity), Brouwer *et al.* (2003) (€63.42 for high level of biodiversity) and Carlsson *et al.* (€76.46 for high level of biodiversity). Respondents' WTP for an increase in the open water surface area from 20 percent to 60 percent is € 20.26, and the average WTP for an improvement in research and educational extraction from the wetland is € 21.36. These are comparable to the average non-use value WTP estimates found by Brouwer *et al.* (2003) of €29.58.

[Table 5]

The implicit prices reported in Table 5 do not provide estimates of compensating surplus (CS) for the alternative management scenarios. In order to estimate the respondents' CS for improvements in wetland management over the *status quo*, three possible options were created.

- *Current scenario-Status quo:* Biodiversity is managed at a low level; open water surface area is low; research and educational extraction is low, and no local farmers are re-trained.
- *Scenario 1- Low impact management scenario:* Biodiversity is managed at a low level; open water surface area is increased to high level; research and educational extraction is low, and 30 local farmers are re-trained.

- *Scenario 2- Medium impact management scenario:* Biodiversity is managed at a high level; open water surface area is low; research and educational extraction is high, and 75 local farmers are re-trained.
- *Scenario 3- High impact management scenario:* Biodiversity is managed at a high level; open water surface area is high; research and educational extraction is high, and 150 local farmers are re-trained.

To calculate the CS associated with each of the above scenarios equation (8) in Section 3 is employed. Note that in order to estimate overall WTP for wetland management it is necessary to include the ASC, which captures the systematic but unobserved information about respondents' choices. The estimates of WTP for the three scenarios are reported in Table 6 below. These are marginal estimates showing WTP for a change from the current situation. For comparisons, CS estimates are calculated using all three models. The results show that the CS estimates from the three models differ significantly, but the order of magnitude remains consistent.

[Table 6]

As expected, the CS for the change from the status quo to the scenarios considered increases as we move towards improved environmental, social and economic conditions in the wetland. Recall that the RPL model with interactions has a better fit than the other two models, and hence it is the preferred one. Mean WTP for the *Low Impact Scenario* is €151.77, whereas greater improvements in environmental, social and economic conditions in the wetland under the *Medium Impact Scenario* increases mean WTP to €203.77, and under the *High Impact Scenario* to as high as €247.73.

6.4 Cost Benefit Analysis

The results can be used to construct a socially efficient design of the wetland by estimating the cost of improving the different attributes of a wetland and by comparing these to the benefits they generate (Carlsson, *et al.*, 2003). The cost estimates for improvements in the different attributes are reported in Table 7. The total cost of providing the *Low Impact Scenario* is €500,872 /annum; the total cost of providing the *Medium Impact Scenario* is €6,314,179 /annum; and the total cost of providing the *High Impact Scenario* is €7,021,358 /annum [5].

[Table 7]

Further, the individual welfare estimates reported in Table 6 for the RPL model with interactions are aggregated over the entire Greek public to determine the total WTP (i.e., total benefits) for the three scenarios described above. Based on the Greek population (10,628,113) and the fraction of respondents who indicated a positive WTP, (82.6%[6]), the aggregate WTP to achieve the environmental and social conditions described in the *Low Impact Scenario* is € 1,332,361,714; in the *Medium Impact Scenario* the aggregate WTP is € 1,788,860,355; and for the *High Impact Scenario*, this amounts to € 2,174,777,326. The aggregate benefits are therefore significantly higher than the total costs of each scenario. More specifically, the aggregate net benefits from the *Low Impact Scenario* is € 1,331,860,842; €1,782,546,176, for the *Medium Impact Scenario* and € 2,167,755,968 for the *High Impact Scenario*. Thus, the total net benefits of wetland management increase in the impact of the management scenario, however at a decreasing rate.

7. Policy Implications and Conclusions

This paper contributes to the limited literature on estimation of non-use values of wetlands using choice experiments, and is one of the few wetland valuation studies that has been undertaken in Greece. The results indicate that there are positive and significant non-use values associated with environmental, economic, and social attributes of the wetland. The impacts of social, economic, and attitudinal characteristics of respondents on their valuation of wetland attributes are significant and conform with economic theory. These results assert that choice experiments can produce valid non-market estimates of non-use value.

[5] To estimate the annual profit loss per farmer, the following data was used: Total area of cultivated land, (L): 6250 ha; Total number of farmers, (F): 1470; Average land per farmer (L/F): 4.25 ha. Therefore, average annual profit loss per farmer is 6762.39 (4.25 x 1591.15). Thus for example, the total cost of the high impact scenario is calculated as: [Biodiversity high (4,000,000 + 1,000,000 + 25,000) + OWSA high (200,000) + Research and Education Extraction high (600,000 + 84,000) + Re-training 150 farmers (98,000 + (6762.39x150))] = €7,021,358 for the first year.

[6] To determine what fraction of the population to aggregate over, genuine zeros (i.e., those who always chose 'neither management scenario' option) were included, and a value of zero was assigned to a protest answer.

The benefits derived from various wetland management scenarios are compared to their costs. The results reveal that social welfare maximisation is achieved under the High Impact Scenario which provides high levels of biodiversity, open water surface area, research and education extraction, and the retraining of 150 locally employed farmers in environmentally friendly agriculture. This study is expected to provide policy-makers with useful information for management of other wetlands in Greece, as well as in Europe, given the current mandate under the European Union's Water Framework Directive and the obligations of the Ramsar Conventions.

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10. Tables

Table 1. Wetland management attributes and levels used in the CE

Attribute	Definition	Management levels
Biodiversity	The number of different species of plants, animals, their population levels, the number of different habitats and their size.	Low: Deterioration from current levels High: A 10% increase in population and size of habitats
Open water surface area	The surface area of the lake that remains uncovered by reef beds.	Low: Decrease from the current open water surface area of 20% High: Increase open water surface area to 60%
Research and educational extraction	The educational, research and cultural information that may be derived from the existence of the wetland, including visits by scientists, students, and school children to learn about ecology and nature.	Low: Deterioration from the current levels of extraction High: Improve the level of educational and research extraction by providing better facilities
Re-training of farmers	Re-training of locally employed farmers to environmentally friendlier practices such as eco-tourism, arid-crop production etc.	Number of farmers re-trained to environmentally friendlier practices: 30, 50, 75, 150
Payment	A one-off payment to go to the Cheimaditida Wetland Management Fund.	4 payment levels from the CV study: € 3, €10, €40, €80

Table 2. Social, economic and attitudinal characteristics of the respondents

Variable	Sample average*	Greek average**
Heard of the wetland (%heard)	32.7%	-
Visited the wetland (%visited)	19.5%	-
Environmentally consciousness index (ECI) (1-20)	5.3	-
Gender (% female)	49.9%	50.5%
Age	39.2	40.2(a)
Household size	3.2	3.5
Children (% with children)	51.2%	68%
Number of dependent children in the household	0.8	1.1
Education (% with university degree and above)	54.3%	18%
Employment (% with full time employment)	57.6%	46.7%
Tenure (% own property)	78.2%	80%
Income (net, in € per month)	1850.6	1358
Distance from the wetland (in km)	204.2	-
Urban (% located in Athens and Thessaloniki)	46.4%	58%
Sample size	407	10,628,113

* Source: Cheimaditida Wetland Management Choice Experiment Survey, 2005
**Source: National Statistical Service of Greece (NSSG) (2003) www.statistics.gr
[a]Median age

Table 3. CL, RPL and RPL with interactions estimates for wetland management attributes

	CL Model	RPL Model		RPL Model with Interactions	
Attributes and interactions	Coefficient (s.e.)	Coefficient (s.e.)	Coeff. Std. (s.e.)	Coefficient (s.e.)	Coeff. Std. (s.e.)
ASC	0.784*** (0.064)	1.748*** (0.509)	2.30*** (0.88)	1.239*** (0.261)	0.958** (0.568)
Biodiversity	0.222*** (0.025)	0.325*** (0.065)	0.069 (0.258)	0.329*** (0.055)	0.090 (0.234)
Open water surface area	0.140*** (0.027)	0.227*** (0.064)	0.707*** (0.262)	0.182*** (0.054)	0.881*** (0.225)
Research and education	0.124*** (0.026)	0.195*** (0.055)	0.462* (0.335)	0.192*** (0.051)	0.472** (0.278)
Re-training	0.002*** (0.001)	0.003*** (0.001)	0.012*** (0.005)	0.003*** (0.001)	0.009*** (0.003)
Payment	-0.014*** (0.001)	-0.021*** (0.004)	-	-0.163*** (0.026)	-
Payment*Age	-	-	-	0.006*** (0.001)	-
Payment*Age2	-	-	-	$-0.7\text{x}10^{-4}$*** ($0.1\text{x}10^{-4}$)	-
Payment*Education	-	-	-	0.012*** (0.003)	-
Payment*Income	-	-	-	$0.4\text{x}10^{-5}$*** ($0.1\text{x}10^{-5}$)	-
Payment*Children	-	-	-	-0.013*** (0.004)	-
Payment*ECI	-	-	-	0.002*** (0.0005)	-
Payment*Distance	-	-	-	$0.4\text{x}10^{-4}$*** ($0.81\text{x}10^{-5}$)	-
Log likelihood	-3325.697	-3316.284		-2540.527	
ρ^2	0.0703	0.0729		0.1214	
Sample size	3256	3256		3256	

Source: Cheimaditida Wetland Management Choice Experiment Survey, 2005

*** 1% significance level, ** 5% significance level, *10% significance level with two-tailed tests

Table 4. Test of Independence of Irrelevant Alternatives

Alternative dropped	χ^2	D.o.f.	Probability
Scenario A	23.36	5	0.0003
Scenario B	54.92	5	0.0000
Scenario C	93.05	5	0.0000

Source: Cheimaditida Wetland Management Choice Experiment Survey, 2005

Table 5. Marginal WTP for wetland management attributes (€ / respondent) and 95% C.I.

Attributes	CL Model	RPL Model	RPL Model with Interactions
Biodiversity	15.62 (13.55-17.69)	15.44 (13.57-17.31)	36.68 (27.99-45.37)
Open water Surface area	9.86 (7.90-11.82)	10.79 (8.80-12.78)	20.26 (14.05-26.47)
Research and education	8.69 (6.80-10.58)	9.27 (7.45-11.09)	21.36 (15.41-27.31)
Re-training (per person)	0.122 (0.078-0.166)	0.129 (0.078-0.181)	0.316 (0.197-0.435)

Source: Cheimaditida Wetland Management Choice Experiment Survey, 2005

Table 6. Compensation Surplus for each scenario (€ / respondent)

Scenario	CL Model	RPL Model	RPL Model with Interactions
1 – Low impact	83.77	62.24	151.77
2 – Medium impact	103.71	81.87	203.77
3 – High impact	122.72	10.43	247.73

Source: Cheimaditida Wetland Management Choice Experiment Survey, 2005

Table 7. Cost estimates for improvement in wetland management

Management Intervention	Cost in € (2005)[a]
Biodiversity:	
1. Improve water quantity by switching to water-saving irrigation technologies and construction of a dyke	4,000,000
2. Improve water quality with construction of waste water treatment plant	1,000,000
3. Protection, conservation, and restoration of Priority Natural Habitats (92/43/EEC)	25,000
Increase OWSA:	
Open and maintain corridors in the reed bed	200,000
Research and Education Extraction:	
1. Construction of a visitor centre	600,000
2. Monthly two-day researcher's bench (collect data/samples, sort and browse)	84,000 /annum
Retraining Farmers:	
1. Two seminars of 100 hrs for beginners, theory and practice	98,000
2. Cost (i.e., farmers profit loss) of switching to non-irrigated crops[b]	1591.15 /ha/annum

Source: Miltos Seferlis, personal communication (EKBY, 2005).

[a] These are one-time costs, unless otherwise indicated

[b] This is the difference between gross margin for non-irrigated crops (76.63 €/ha/annum), and gross margin for irrigated crops (1667.78 €/ha/annum).

11. Figures

Figure 1. Sample choice set

Which of the following wetland management scenarios do you favour? Option A and option B would entail a cost to your household. No payment would be required for "Neither management scenario" option, but the conditions at the wetland would continue to deteriorate.			
	Wetland management Scenario A	Wetland management Scenario B	Neither management scenario A nor management scenario B: I prefer NO wetland management
Biodiversity	Low	High	
Open water surface area	Low	Low	
Research and education	High	Low	
Re-training of locals	50	50	
One-off payment	€ 3	€ 10	
I would prefer: (Please tick as appropriate)	Choice A	Choice B	Neither