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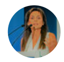
Ekin Birol



Phoebe Koundouri
Athens University of Economics and Business

UNIVERSITY OF
CAMBRIDGE
Department of Land Economy

Environmental Economy and Policy Research

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Using a choice experiment to estimate the non-use values of wetlands: The case of Cheimaditida wetland in Greece

by

Ekin Birol, Katia Karousakis
and Phoebe Koundouri

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Birol, E., Karousakis, K. and Koundouri, P.

Department of Land Economy and Homerton College, University of Cambridge, Cambridge, UK.
Department of Economics, University College London, London, UK.
Department of Economics, Reading University, Reading, UK.

Abstract

Despite wetlands being amongst the Earth's most productive ecosystems, they 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, 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 study 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. Results from this choice experiment reveal that there are positive and significant non-use values of this wetland for whose conservation the public is willing to pay. These results can be combined with private use values of wetlands, and weighed against the costs of alternative wetland management scenarios in order to carry out a comprehensive 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.

Address for correspondence
Dr. Ekin Birol
Homerton College, University of Cambridge
Hills Road, Cambridge, CB2 2PH, UK
Tel: +44 (0) 1223 507230
Fax: +44 (0) 1223 507206
Email: eb337@cam.ac.uk

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; Brouwer *et al*, 2003; Woodward and Wui, 2001; 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. Even though the amount of wetland area lost is difficult to quantify since the total area of wetland 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 the United States has lost 54 percent of its original wetlands during the same period (Barbier *et al.*, 1997).

Alarmed by the accelerated rate of wetland loss and degradation, 100 countries created the Ramsar Convention on Wetlands of International Importance in 1971, 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. In addition 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 the 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, Greece 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 that the wetland generates in terms of non-use values that accrue to the Greek public[1]. The non-use values estimated in this study can in turn be used in cost-benefit analysis of alternative wetland management scenarios, thereby enabling sustainable management of the Cheimaditida wetland. To accomplish this aim, the non-use values of the Cheimaditida wetland are estimated by using a recently developed non-market valuation method, namely a choice experiment. 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

[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.

and educational extraction from the wetland, and locals employed in environmentally friendly occupations.

The paper unfolds as follows: The next section presents the choice experiment method and some previous applications. The third section describes the case study site and section 4 describes the choice experiment design and administration. The results of the econometric analysis are reported in section 5, and section 6 concludes the paper with a discussion of the results and policy implications.

2. Choice experiment method

2.1. Theoretical Background

Since most of the outputs, functions and services that wetlands generate are not traded in the markets, non-market valuation techniques must be used to determine the value of their benefits. Private benefits generated by the use values of the Cheimaditida wetland accrue to the local population and 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.

Within the range of non-market valuation techniques, the choice experiment method (CEM) is most appropriate for capturing the benefits generated by the multiple services and functions of wetlands. This 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.*, 1998a; Bateman *et al.,* 2003). CEM has its theoretical grounding in Lancaster's model of consumer choice (Lancaster, 1966) and its econometric basis in random utility models (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 this choice experiment, 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 options. The respondent is assumed to have a utility function of the form

$$U_{ij} = V(Z_{ij}, S_i) + e_i \qquad (1)$$

where for any respondent *i,* a given level of utility will be associated with any alternative wetland management scenario *j*. Utility derived from any of the wetland management scenario alternatives depends on the attributes (Z) of the wetland management scenario and the social and economic characteristics (S) of the respondent.

The random utility approach is the theoretical basis for integrating behaviour with economic valuation in the choice experiment. In this approach, the utility of a choice is comprised of a deterministic component (the first term on the right hand side of equation (1)) and an error component, e_i, 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 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 model (McFadden 1974; Greene 1997 pp. 913-914; Maddala 1999, pp. 42), which takes the general form

$$P_{ij} = \frac{e^{V_{ij}}}{\sum_{h \in C} e^{V_{ih}}} \qquad (2)$$

The conditional indirect utility function generally estimated is

$$V_{ij} = \beta + \beta_1 Z_1 + \beta_2 Z_2 + ... + \beta_n Z_n + \beta_a S_1 + \beta_b S_2 + ... + \beta_m S_k \qquad (3)$$

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

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

$$CS = \frac{\ln \sum_i \exp(V_{i1}) - \ln \sum_i \exp(V_{i0})}{\alpha} \qquad (4)$$

where CS is the compensating surplus welfare measure, α is the marginal utility of income (generally represented by the coefficient of the monetary attribute in the choice experiment) and V_{i0} and V_{i1} 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 (4) to

$$W = -1\left(\frac{\beta_{attribute}}{\beta_{monetary\ variable}}\right) \tag{5}$$

This part-worth (or implicit price) formula represents the marginal rate of substitution between income and the attribute in question, i.e., the marginal welfare measure (willingness to pay or willingness to accept), for a change in any of the attributes. To estimate the value of changes in the quality or quantity of various wetland management scenarios, equation (4) simplifies to

$$W= -(V_0 - V_1)/\beta_{monetary\ variable} \tag{6}$$

2.2. Previous Applications

The choice experiment method was initially developed by Louviere and Hensher (1982) and Louviere and Woodworth (1983) in marketing economics literature, and has been used in the environmental economics literature for valuation of non-market environmental goods only within the last decade. Although a relatively new addition to the portfolio of non-market valuation methods, there is already a noteworthy and ever-increasing number of applications of choice experiments.

The earliest applications of CEM in the environmental economics literature are those of Adamowicz *et al.* (1994) on alternative flow scenarios for rivers in Canada, and Boxall *et al.* (1996) on recreational moose hunting. Bergland (1997) uses CEM to value changes in agricultural landscapes in Norway. Hanley *et al.* (1998b) employ CEM to value the attributes of public woodlands in the UK, and Hanley *et al.* (1998c) use CEM to aid in the design of Scottish agri-environmental programmes that yield the highest benefits to the society. Layton *et al.* (1999) adopt CEM to value multiple programmes to improve fish population, and Rolfe *et al.* (2000) investigate the preferences of Australian public for various tropical rainforest conservation strategies. Layton and Brown (2000) employ this method to investigate the preference of the public for policies that aim to mitigate the impacts of climate change. Scarpa *et al.* (2003) use CEM to estimate the value of non-market traits of traditional animals to farm families in Yucatan, Mexico. Most recently Colombo *et al.* (2004) employ this method to investigate public preferences to help design policies for reducing the off-farm effects of soil erosion in Spain.

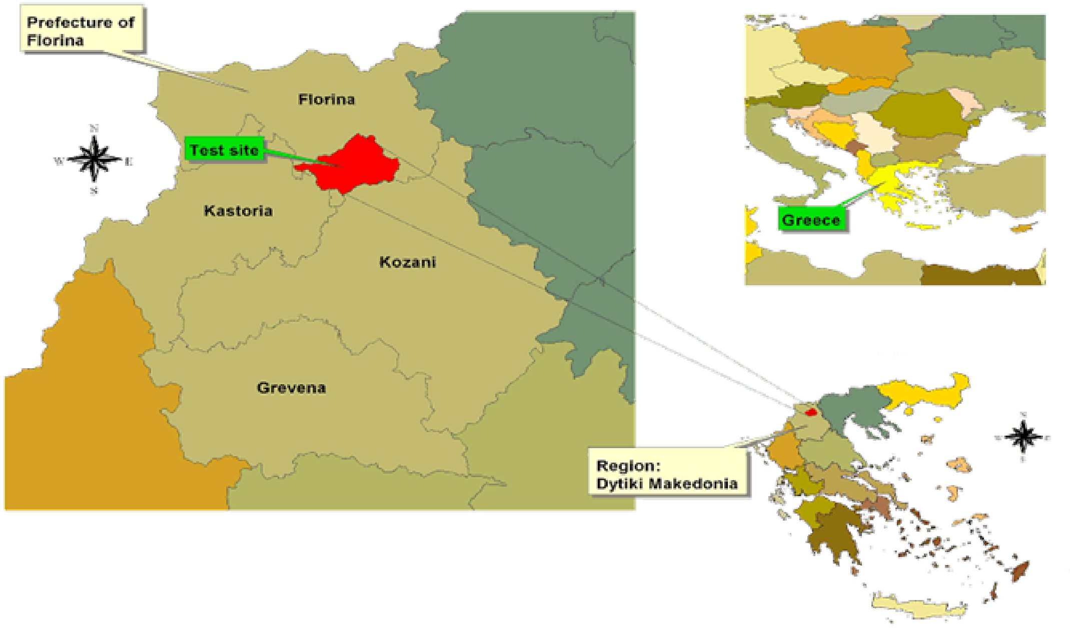
There are to date only two applications of the CEM to estimation of non-use values of functions and services of wetlands. The first is that of Morrison *et al.* (1999) who investigate the non-use values of Macquarie Marshes wetland in Australia, as they accrue to the Australian public. The second application is that of Carlsson *et al.* (2003), who estimate both use and non-use values of the Staffanstorp wetland in Sweden. The choice experiment on the Cheimaditida wetland presented in this paper is a valuable addition to this scant literature.

3. Cheimaditida Wetland Case Study

The case study in this paper is the Cheimaditida wetland, located 40 km Southeast of Florina in Northwest Greece (Figure 1). 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, Cheimaditida wetland is recognised as an ‘Important Bird Area’ with approximately 140 bird species identified. 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*) (Seferlis, 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, are adversely affecting water quantity and quality. These in turn affect the level of biodiversity that the wetland is able to support. Current local employment in agriculture and fisheries supported by the wetland is estimated at 1550. This is expected to fall to about 1470 within the next 5 years as declining quality and quantity of water will no longer be able to support the current number of locals (Seferlis, 2004; Psychoudakis *et al.,* 2004).

Figure 1. Map of the Cheimaditida wetland



4. Choice Experiment Design and Application

4.1. Choice Experiment Design

The first step in CE design is to define the good to be valued in terms of its attributes and levels these attributes take. In the CE reported in this paper, the good to be valued 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 existing valuation studies of non-use values, and the specific issues pertaining to the Cheimaditida wetland. Finally, focus groups were conducted to determine the final attributes and their levels that are important to the 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). 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 to scientific knowledge. Finally, re-training of locals in environmentally friendly occupations are expected to generate non-use values to the wider Greek public.

A further underlying criteria in the selection of the attributes was that each was directly associated with a separate and distinct management strategy. Thus, improving the existing biodiversity level to a high status requires management strategies targeted towards water quality and quantity (e.g., pollution run-off and irrigation); the enlargement of the open water surface area entails regular interventions to create and maintain water corridors through the existing reef beds; the research and educational attribute can be enhanced by the building of additional structures and facilities (e.g., books, microscopes); and the non-use values of employment can be supported by re-training locals to alter their agricultural management and fishing practices into more environmentally friendly occupations such as arid-crop production and eco-tourism.

[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 that are 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 choice experiment were €3, €10, €40 and €80.

A large number of unique wetland management scenarios can be constructed from this number of attributes and levels. More precisely, 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 $4^2*2^3=128$. 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 2.

Table 1: Wetland management attributes and levels used in the choice experiment

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 and fishers	Re-training of locally employed farmers and fishers to environmentally friendlier practices such as eco-tourism, arid-crop production etc.	Number of farmers and fishers 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

Figure 2. Sample choice set

<table>
<tr><td colspan="4">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.</td></tr>
<tr><td></td><td>Wetland management Scenario A</td><td>Wetland management Scenario B</td><td rowspan="6">Neither management scenario A nor management scenario B:

I prefer NO wetland management</td></tr>
<tr><td>Biodiversity</td><td>Low</td><td>High</td></tr>
<tr><td>Open water surface area</td><td>Low (20%)</td><td>Low (20%)</td></tr>
<tr><td>Research and education</td><td>High</td><td>Low</td></tr>
<tr><td>Re-training of locals</td><td>50</td><td>50</td></tr>
<tr><td>One-off payment</td><td>€ 3</td><td>€ 10</td></tr>
<tr><td>I would prefer:
(Please tick as appropriate)</td><td>Choice A ☐</td><td>Choice B ☐</td><td>Neither ☐</td></tr>
</table>

4.2. 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 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 and economic 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. Individuals were approached in coffee shops, parks, government office buildings and private companies, as well as on the street. The choice experiment 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 location of the wetland in Greece was shown to each of the respondents, along with colour photographs of the wetland. Enumerators described the Cheimaditida wetland, its location, ecological importance and threats to its sustainable 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 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 (Table 2).

Table 2. Sampled cities, population levels and distance from the wetland

Location	Population	Distance in km	Sample size
Amyntaio	3000	15	5
Ptolemaida	30000	20	15
Florina	16000	40	40
Edessa	25000	55	35
Kozani	60000	60	38
Veroia	60000	110	40
Naoussa	10000	120	30
Chalkithona	5000	140	15
Thessaloniki	1 200 000	170	100
Athens	5 000 000	560	89
Total	6 409 000		407

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, but also to use these data as explanatory variables to investigate variation in valuation. The descriptive statistics of the sample are presented in Table 3.

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) was calculated using the Likert scores and environmental group membership. The ECI ranged from 0 to 20.

Table 3. 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

5. 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 levels were coded as 1 and low levels were coded as –1. For open water surface area, an increase to 60% was entered as 1 and the low level of 20% was entered as –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 and fishers 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 'neither management scenario' option was selected. The choice data were then converted from wide format to long format with a program coded in LIMDEP 7.0 NLOGIT 2.0 This data conversion step is necessary to estimate models with multiple responses from each respondent (i.e. a format similar to panel data).

5.1 Basic 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 alternative specific constant. Using the 3256 choices elicited from 407 respondents, four conditional logit models with logarithmic and linear specifications for the attributes with four levels were estimated and compared using LIMDEP 7.0 NLOGIT 2.0. The highest value of the log-likelihood function was found for the specification with both four-levelled attributes in linear form. For the population represented by the sample, indirect utility from wetland management takes the following form:

$$V_{ij} = \beta + \beta_1 \ln(Z_{Biodiversty}) + \beta_2 (Z_{OWSA}) + \beta_3 (Z_{RE}) + \beta_4 (Z_{\mathrm{Re}-training}) + \beta_5 (Z_{Payment}) \qquad (7)$$

where β refers to the alternative specific constant and β_{1-5} refer to the vector of coefficients associated with the vector of attributes describing the wetland attributes. The results of the conditional logit estimates for the sample is reported in Table 4.

Table 4. Conditional Logit Estimates for Wetland Management Attributes

	Basic Conditional Logit Model	Conditional Logit Model with Interactions
Attributes and interactions	Coefficient (s.e.)	
ASC	0.784*** (0.064)	-3.230*** (0.165)
Biodiversity	0.222*** (0.025)	0.273*** (0.040)
Open water surface area	0.140*** (0.027)	0.114** (0.045)
Research and education	0.124*** (0.026)	0.103** (0.043)
Re-training	0.002*** (0.001)	0.008*** (0.001)
Payment	-0.014*** (0.001)	-0.033*** (0.003)
ASC*Dependent children	-	5.285*** (1.091)
ASC*Urban	-	3.586*** (0.798)
ASC* Education	-	4.439*** (0.782)
ASC* ECI	-	2.532*** (0.246)
Biodiversity *Dependent children	-	0.055* (0.032)
OWSA* Urban	-	0.186*** (0.066)
Research and education*Urban	-	0.163*** (0.063)
Re-training* ECI	-	-0.001*** (0.0002)
Payment* Education	-	0.007*** (0.002)
Payment* ECI	-	0.002*** (0.0004)
Log likelihood	-3325.697	-1565.081
ρ^2	0.070	0.515
Sample size	3256	2935

Source: Cheimaditida Wetland Management Choice Experiment Survey, 2005
*** 1% significance level, ** 5% significance level, *10% significance level with two-tailed tests

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[3] (Ben-Akiva and Lerman, 1985), the coefficients are significant at the 1% level or less 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. The sign of the payment coefficient indicates that the effect on utility of 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. These are followed by the re-training of locals attribute (per person). These results indicate that positive and significant non-use values exist for both environmental and economic and social attributes of the wetland.

The negative sign on the ASC coefficient implies that respondents are highly responsive to changes in choice set quality and they make decisions that are closer both to rational choice theory and the behaviour observed in reality (Kontoleon, 2003). Further, 19.2 percent of the respondents consistently chose the "neither management scenario" option in all 8 choice sets presented to them. Of these, 88 percent agreed with the statement that wetland management was the responsibility of the government, 9.6 percent indicated that they did not care about wetlands, 91.1 percent indicated that they did not believe the funds would be used correctly, and 40.3 percent indicated that they did not have the financial ability to contribute to the management fund. In addition, a number of respondents stated that they felt that only local residents should contribute to the fund as they were the ones living nearby and were therefore responsible for its management; others stated that the polluters should pay for the restoration

[3] 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.

and management of the wetland. Additional concerns that arose included the free-riding problem (several respondents claimed they would only wish to contribute to the fund if all the Greek population were required to contribute), and a large number of respondents re-emphasized their distrust in the management and allocation of the funds[4].

The assumptions about the distributions of error terms implicit in the use of the conditional logit 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 conditional logit model was appropriate, the Hausman and McFadden (1984) test for the IIA property was 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 5 below, indicating that IIA property cannot be rejected at the 99% level. Therefore the conditional logit model is the appropriate model for estimation of this data.

Table 5. 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

4 Pairwise *t*-tests and Pearson Chi square tests were also conducted to examine whether the social and economic characteristics of respondents selecting option A or B in at least one of their choice sets were statistically different from those who consistently selected ‘neither management scenario’. The results revealed that latter group had a statistically significantly lower level of income and education.

5.2. Conditional Logit Model with Interactions

Basic conditional logit model assumes homogeneous preferences across respondents. However, preferences 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).

One way of accounting for preference heterogeneity is by using respondent's social, economic and attitudinal characteristics directly as interaction terms. Interaction of respondent-specific 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 (see for example Rolfe *et al.*, 2001). The main problem with this method is multicollinearity, which occurs when too many interactions are included in the estimation, hence the model needs to be tested down, using the higher log-likelihood criteria (Breffle and Morey, 2000).

To account for heterogeneity of preferences across respondents the effects of social, economic and attitudinal characteristics of the respondents on their choice of wetland management scenario must be investigated. As already mentioned in Section 2, in random utility models the effects of social and economic characteristics on choice cannot be examined in isolation but as interaction terms with choice attributes. Due to possible multicollinearity problems, it is not possible to include all the interactions between the social, economic and attitudinal characteristics of the respondents collected in the survey (as reported in Table 3) and the five wetland management attributes when estimating the conditional logit model with interactions (Breffle and Morey, 2000).

To address this limitation, independent variables were eliminated based on Variance Inflation Factors (VIF), which were calculated by running "artificial" ordinary least squares regressions between each independent variable (i.e., social, economic and attitudinal characteristics of the respondents) as the "dependent" variable and the remaining independent variables[5]. Those independent variables for which $VIF_j > 5$ indicate clear evidence that the estimation of the characteristic is being affected by multicollinearity (Maddala, 2000). Four independent variables were selected:

1) Environmental consciousness index (ECI)
2) Education
3) Number of dependent children in the household
4) Urban location

The indirect utility function in equation (7) was then extended to include the 24 interactions between the ASC, five wetland management attributes and the four respondent characteristics. Using LIMDEP 7.0 NLOGIT 2.0, the final conditional logit function estimated is:

$$
\begin{aligned}
V_{ij} &= \beta + \beta_1 \ln(Z_{Biodiversity}) + \beta_2 (Z_{OWSA}) + \beta_3 (Z_{RE}) + \beta_4 (Z_{\mathrm{Re}-training}) + \beta_5 (Z_{Payment}) \\
&\delta_1 (\beta \times S_{ECI}) + \delta_2 (Z_{biodiversity} \times S_{ECI}) + \delta_3 (Z_{OWSAy} \times S_{ECI}) + ... + \delta_6 (Z_{Payment} \times S_{ECI}) \\
&\delta_7 (\beta \times S_{education}) + \delta_8 (Z_{Biodiversity} \times S_{education}) + ... + \delta_{12} (Z_{Payment} \times S_{education}) + ... \qquad (8) \\
&+ \delta_{19} (\beta \times S_{urban}) + \delta_{20} (Z_{Biodiversity} \times S_{urban}) + ... + \delta_{24} (Z_{Payment} \times S_{urban})
\end{aligned}
$$

Therefore all variables were initially interacted with both the attributes and the ASC, and were deleted if they were insignificant. The statistically significant effects of the social, economic and attitudinal characteristics of the respondents on their choice of wetland management attributes are reported in Table 4. The sample size is now 2935 as a result of missing data on some of the characteristics of the respondents. This model has a higher overall fit compared to the basic conditional logit model, with a ρ^2 of 0.515.

As it can be seen from the positive interactions between the ASC and the four characteristics, higher levels of ECI and higher numbers of dependent children, as well as having a university degree and being located in the urban areas increases the likelihood that the respondent will select a wetland management scenario. Respondents with university education and higher ECI's are more likely to choose higher payment levels, as the interaction between both of these characteristics and payment attribute are positive. Respondents located in the urban areas prefer higher levels of open water surface area, as well as higher levels of research and educational extraction from the wetland. Finally, those respondents with higher numbers of dependent children are more likely to choose wetland management scenarios with higher levels of biodiversity, thereby revealing their bequest motives.

5.3. Random Parameter Logit Model

An alternative method for accounting for preference heterogeneity is the use of the random parameter logit model. Even though the use of social, economic and attitudinal characteristics help to recognise conditional 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 random parameter logit model, which, unlike conditional logit model, is not based on the IIA assumption.

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[5] Variance Inflation Factors (VIF_j) for each such regression are calculated as: $VIF_j = \frac{1}{1-R_j^2}$,

where R_j^2 is the R^2 of the artificial regression with the jth independent variable as a "dependent" variable.

The random utility function in the random parameter logit model is given by

$$U_{ij} = V_{ij} + \varepsilon_{ij} \equiv Z_j(\beta + \eta_i) + e_{ij} \qquad (9)$$

where respondent *i* receives utility U from choosing alternative *j* from choice set C. Similarly to conditional logit model, utility is decomposed into a non-random component (*V*) and a stochastic term (*e*). Indirect utility is assumed to be a function of the choice attributes Z (as well as of social and economic characteristics S, if included in the model) with parameters β, which due to preference heterogeneity may vary across respondents by a random component η_i. 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 (Revelt and Train, 1998). With accounting for unobserved heterogeneity, equation (2) in Section 2 above now becomes

$$P_{ij} = \frac{e^{Z_{ij}(\beta+\eta_i)}}{\sum_{h \in C} e^{Z_{ih}(\beta+\eta_i)}} \qquad (10)$$

Since this model does not require 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 random parameter logit model have shown that this model is superior to conditional logit model in terms of overall fit and welfare estimates (Breffle and Morey, 2000; Layton and Brown, 2000; Kontoleon, 2003;

Lusk *et al.,* 2003; Morey and Rossmann, 2003). However, it should also be noted that even if unobserved heterogeneity can be accounted for with the use of the random parameter logit 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 would be by inclusion of respondent characteristics in the utility function as interaction terms. This would enable random parameter logit 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 (see for example Morey and Rossmann, 2003).

In this paper the random parameter logit model was estimated using LIMDEP 7.0 NLOGIT 2.0. All the parameters were specified to be independently normally distributed and distribution simulations were based on 500 draws. The results of the random parameter logit estimations for the pool are reported in Table 6 below.

Random parameter logit model estimates of the sample resulted in insignificant derived standard deviations indicating that data does not support any choice specific unconditional unobserved heterogeneity. Moreover, the log likelihoods are almost the same as the conditional logit model. The Swait Louviere Log Likelihood ratio test cannot reject the null hypothesis that the random parameter logit model and conditional logit model estimates are equal. Hence no improvement in the model fit can be achieved with the use of a random parameter logit model. On the basis of this test it can be concluded that the conditional logit model is sufficient for analysis of the data set presented in this thesis.

Table 6. Random Parameter Logit Estimates for Wetland Management Attributes

Attributes		Coeff. (s.e.)
Constant	Mean coefficient	0.784*** (0.065)
	St. Dev. of coefficient	0.0009 (0.042)
Biodiversity	Mean coefficient	0.222*** (0.026)
	St. Dev. of coefficient	0.0003 (0.026)
Open water surface area	Mean coefficient	0.140*** (0.027)
	St. Dev. of coefficient	0.0008 (0.027)
Research and education	Mean coefficient	0.124*** (0.027)
	St. Dev. of coefficient	0.005 (0.026)
Re-training	Mean coefficient	0.002*** (0.0006)
	St. Dev. of coefficient	0.00001 (0.0004)
Payment	Mean coefficient	-0.014*** (0.001)
	St. Dev. of coefficient	0.00002 (0.0008)
Sample size	9768	
ρ^2	0.069	
Log likelihood	-3325.679	
Replications for simulated probability	500	

Source: Cheimaditida Wetland Management Choice Experiment Survey, 2005
*** 1% significance level, ** 5% significance level, *10% significance level with two-tailed tests

5.4. Estimation of Willingness To Pay

Table 7 reports the implicit prices, or marginal willingness to pay (WTP) values for the each of the wetland management attributes with the respective 95% confidence intervals, calculated using equation (5) in Section 2 above. These are all positive implying that respondents have a positive WTP for increases in the quality or quantity of each attribute. These estimates indicate that, for example, respondents were WTP 12 cents (basic conditional logit model) to 12.3 cents (conditional logit model with interactions) for an extra local re-trained in environmentally friendly employment. Respondents' average WTP for high levels of biodiversity in the wetland ranges from €14.45 to €15.59 depending on the model used. Similarly respondents' WTP for an increase in the open water surface area from 20 percent to 60 percent ranges from €9.07 to € 9.85. Finally the average WTP for an improvement in research and educational extraction from the wetland ranges from €8.09 to € 8.69.

Table 7. Estimates of WTP and confidence intervals, in € per respondent

	Basic Conditional Logit Model	Conditional Logit Model with Interactions
Attributes	Mean WTP	
Biodiversity	15.59	14.45
Open water surface area	9.85	9.07
Research and education	8.69	8.09
Re-training (per person)	0.12	0.123

Source: Cheimaditida Wetland Management Choice Experiment Survey, 2005

The implicit prices reported in Table 7 above, do not provide estimates of compensating surplus. To estimate overall WTP for wetland management it is necessary to include the ASC, which captures the systematic but unobserved information about respondents' choices. In order to estimate the respondents' WTP for alternative wetland management scenarios, four possible options were created. These are presented below.

Current scenario:

Biodiversity is managed at a low level; the open water surface area is at 20%; the research and educational extraction is low, and no local farmers and fishers are re-trained.

Scenario 1: Low impact management scenario

Biodiversity is managed at a low level; the open water surface area is increased to 60%; the research and educational extraction is low, and 50 local farmers and fishers are re-trained.

Scenario 2: Low impact management scenario

Biodiversity is managed at a high level; the open water surface area is low at 20 %; the research and educational extraction is low, and 30 local farmers and fishers are re-trained.

Scenario 3: Medium impact management scenario

Biodiversity is managed at a high level; the open water surface area is low at 20%; the research and educational extraction is high, and 75 local farmers and fishers are re-trained.

Scenario 4 – High impact management scenario.

Biodiversity is managed at a high level; the open water surface area is high at 60%; the research and educational extraction is high, and 150 local farmers and fishers are re-trained.

To calculate the consumer surplus associated with each of the above scenarios equation (6) in Section 2 was employed. The estimates of WTP for the four scenarios are reported in Table 8 below. These are marginal estimates showing WTP for a change from the current situation. When estimating consumer surplus using the conditional logit model with interactions, the attitudinal variable, ECI, and the three social and economic variables were all set to the sample averages.

Table 8. Estimates of Compensation Surplus for each Scenario, in € per respondent

Scenario	Basic Conditional Logit Model	Conditional Logit Model with Interactions
1 – Low impact	16.86	29.74
2 – Low impact	19.86	23.26
3 – Medium impact	35.43	47.71
4 – High impact	56.14	85.88

Source: Cheimaditida Wetland Management Choice Experiment Survey, 2005

As can be seen from Table 8, higher management levels generate higher benefits in both models. Recall that the conditional logit model with interactions has a better fit than the basic model, and hence the former is the preferred model. These individual estimates of WTP can be aggregated to determine the WTP of the wider Greek public to achieve the four scenarios of improved management of the Cheimaditida wetland.

6. Policy Implications and Conclusions

This paper contributes to the scant 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.

The non-use values estimated in this paper can be combined with direct and indirect use values of the Cheimaditida wetland to conduct a cost-benefit analysis. Inclusion of non-use values in benefits estimation enables policy-makers to formulate more informed decisions on the efficient management of the wetland. This study is expected to provide 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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