Using a choice experiment to inform implementation of the European Union Water Framework Directive: the case of Cheimaditida Wetland in Greece

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INTRODUCTION

Water resources include surface water, groundwater, wetlands, inland waters, rivers, lakes, transitional waters, coastal waters and aquifers (Chave, 2001). Together these water resources are crucial to human health, the natural environment and the functioning of any economy in the world, since they are necessary inputs to agriculture, industry, domestic consumption and tourism (UNEP, 2000).

The quality and quantity of water resources have been deteriorating globally at alarming rates however. Though the situation is most severe in developing countries, two-thirds of which are expected to face water shortages by 2030 (FAO, 2003), the situation for water resources in Europe is also far from satisfactory. According to the European Commission's (EC) recent statistics, 20 per cent of all surface water in the European Union (EU) is seriously threatened by pollution. Sixty-five per cent of all Europe's drinking water is provided by groundwater resources, which are being exploited by 60 per cent of European cities. The area of irrigated land in Southern Europe has increased by 20 per cent since 1985, contributing to increasing water scarcity (EC, 2002). In the past century, Europe has lost 50 to 60 per cent of its wetlands, an integral part of water resources which generate an array of important economic functions and services including flood protection, water supply, improved water quality, commercial and recreational fishing and the mitigation of global climate change (Barbier *et al.*, 1997; Woodward and Wui, 2001; Brouwer *et al.*, 2003; Brander *et al.*, 2006). The EC reports that 50 per cent of all remaining European wetlands have ‘endangered status’ due to groundwater overexploitation (EC, 2002).

In response to the increasing pressures on the quality and quantity of European water resources, the EU established the Water Framework Directive in 2000 (WFD, 2000/60/EC). The WFD aims to tackle the water resource problems and to secure these resources for future generations by employing an integrated environmental management approach. This approach considers both water quality and quantity issues, as well as those related to all forms of water resources (Chave, 2001; EC, 2002). According to this Directive, member states are obliged to restore and upgrade the quality and quantity of their water resources to a ‘good status’, and to ensure their sustainable use by 2015. For surface waters, ‘good status’ is considered to be ‘good ecological quality’ and ‘good chemical status’, whereas for groundwaters, ‘good status’ implies ‘good quantitative status’ and ‘good chemical status’. To ensure a ‘good status’ for European wetlands, the WFD calls for the protection, restoration and enhancement of the water needs of wetlands and stresses the EU’s involvement in wetland protection and enhancement and its commitment to setting up strategic policies for these purposes. Further, the EU calls for active participation and consultation of all stakeholders in water management activities, including local communities and citizens groups (Chave, 2001; EC, 2002).

In relation to other EU countries, Greece is generously endowed with freshwater resources although these are unevenly distributed across the country. Some 85–90 per cent of freshwater resources are in the form of surface water and 10–15 per cent are groundwater (OECD, 2000). Like other EU countries, the quality and quantity of water resources have been deteriorating in Greece. Water demand has increased significantly over the past 30 years, with serious water imbalances due to temporal and regional variations in precipitation (Angelakis and Diamandopoulos, 1995). Intensive agricultural production and an ever-growing tourism sector are considered among the major sources of water resources deterioration. Some 35 per cent of the country is in danger of land damage through drought, largely because of wasteful irrigation, which constitutes about 87 per cent of total freshwater withdrawals (WWF, 2003). As a result of tourism, which accounts for over 18 per cent of Greece’s GDP, more than thirty Greek islands are facing serious water supply problems (US Water News, 2006). Lake water quality degradation has been apparent for decades such that today, most Greek lakes (except deep ones) are eutrophic.

In addition, between 1920 and 1991, Greece lost 63 per cent of its wetlands (Barbier *et al.*, 1997). Most remaining inland wetlands are threatened, including some rare types. Coastal wetlands suffer particularly heavy pressure from human activities. The main factors causing wetland degradation are: construction of irrigation projects and diversion of watercourses, causing changes in water flow; overpumping, land clearing and illegal hunting, causing depletion of water resources and wildlife; agricultural run-off and municipal waste water, causing water pollution; and urban development and expansion of cultivated areas, causing loss of wetland area. Eutrophication occurs in coastal wetlands near big cities and in inland wetlands in areas with intensive farming (OECD, 2000).

As an EU member country, Greece is obliged to ensure sustainable integrated management of all of its water resources, according to the requirements of the WFD. The existing management of water resources is neither integrated nor adequate however (WWF, 2003), and there is an urgent need for development and implementation of an efficient institutional structure and economic instruments for the sustainable management of water resources in accordance with the WFD. In addition to the WFD, there are other EU regulations Greece must abide by, such as the EU Birds Directive (1979/409/EC) and the EU Habitats Directive (1992/43/EC), which aim to conserve several ecological functions that are provided by water resources, predominantly by wetlands.

The aim of this chapter is threefold. First, to demonstrate that the choice experiment method can be employed to capture the total economic values of water resources, such as wetlands, which generate both use and non-use values. To this end, the value of the economic benefits generated by sustainable management of the Cheimaditida Wetland in Greece is estimated using data from 407 respondents located in 10 cities and towns in Greece. The results reveal that the choice experiment method is suitable for valuation of the various use and non-use values generated by water resources, such as wetlands.[2] The second aim of this chapter is to provide policy makers with much-needed information for efficient, effective and sustainable management of this wetland, in accordance with the EU WFD, as well as the Habitats and Birds Directives. Consequently, the estimated total economic benefits generated by various alternative wetland management options are weighted against their corresponding costs. The results reveal the wetland management strategy that maximises social welfare, and these findings have implications for sustainable, efficient and effective management of similar wetlands in Greece and other EU countries.

The final aim of this chapter is to adapt the latent class model introduced in Chapter 7 of this volume, to the estimation of the economic value of wetlands. The aim of this exercise is to reveal that estimation of preference heterogeneity is important not only for private goods, that is, genetically modified food as investigated in Chapter 7, but also for pure or impure public goods, such as water resources. The results of the latent class model reveal that overall the Greek public derive positive and significant benefits

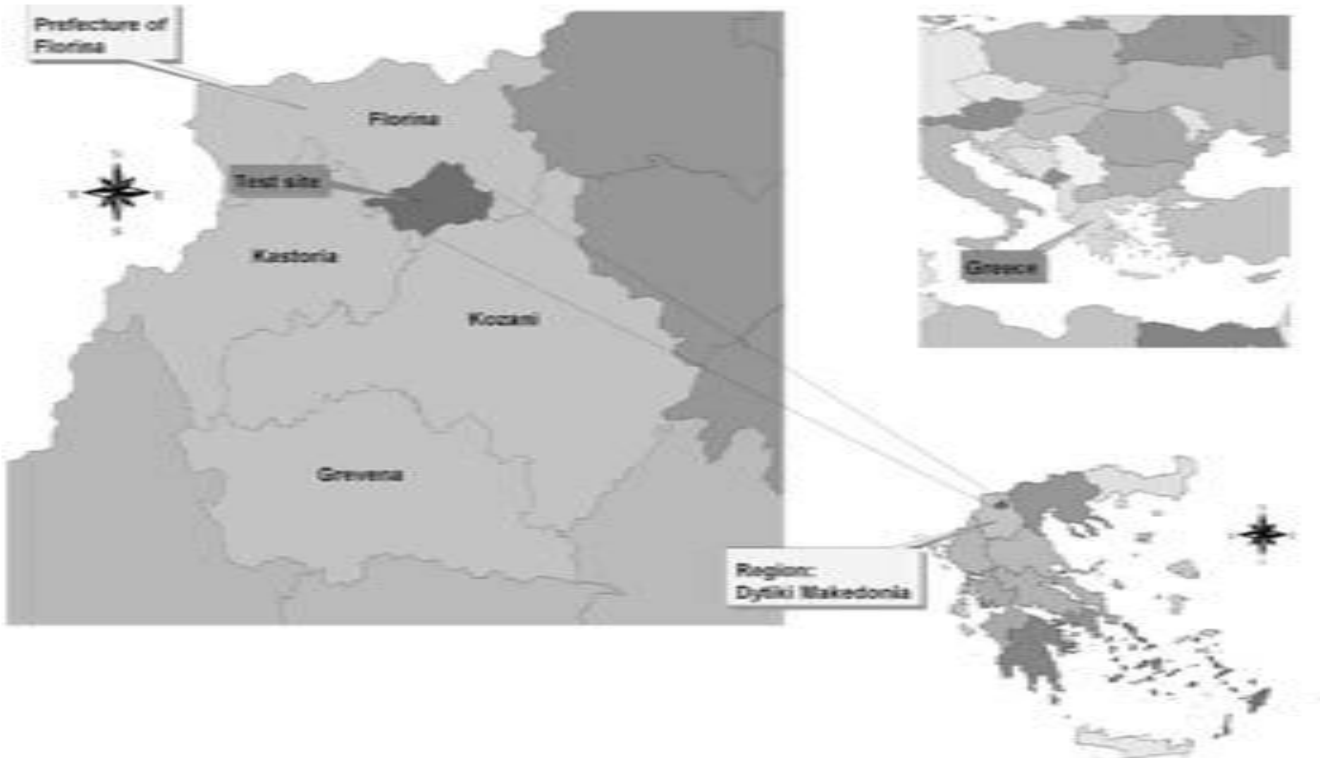

Figure 11.1 Location of Cheimaditida Wetland

from sustainable management of several ecological, social and economic functions of the wetland, including biodiversity, open water surface area, research and educational opportunities from the wetland, and locals re-trained in environmentally friendly employment. There is, however, a considerable level of heterogeneity in the public's preferences for these functions, which should be taken into consideration when designing efficient, effective and equitable wetland management programmes, targeted at different segments of the population.

The chapter is organised as follows: The next section describes the Cheimaditida case study site, followed by a description of the choice experiment design and administration. The results of the econometric analysis are then reported; the final section concludes the chapter and draws out policy implications for implementation of the European Union's Water Framework Directive, as well as the Habitats and Birds Directives in Greece and in other EU countries.

THE CHEIMADITIDA WETLAND

The case study reported in this chapter is the Cheimaditida Wetland, located 40 km southeast of Florina in Northwest Greece (Figure 11.1). It includes Lake Cheimaditida, one of the few remaining freshwater lakes in Greece, and constitutes a total wetland area of 168 sq. km 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, 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 Annexes II and IV of the EU Habitats Directive. 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*), the 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 alfalfa and maize are the main cash crops whose production is water- and fertiliser-intensive.

Water opportunities 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 persons. This is expected to fall, as the 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).

CHOICE EXPERIMENT DESIGN AND APPLICATION

Choice Experiment Design

The first step in choice experiment design is to define the good to be valued in terms of its attributes and their levels. The good to be valued in this choice experiment study is the wetland management scenario. Significant wetland management attributes pertaining to the Cheimaditida Wetland 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. Three focus groups were then conducted with members of the Greek public to determine the final attributes and their levels that are important to them, as well as the vocabulary and language to be used in the survey.

The selected attributes and their levels are reported in Table 11.1. Economic benefits may be derived from social and economic factors in addition to the ecological factors (Portney, 1994). Several studies have included social and economic factors, such as number of farmers employed or living in the countryside, in choice experiment studies to capture the economic benefits enjoyed by the wider public from provision of such factors (for example, Morrison *et al*., 1999; Bennett *et al*., 2004; Othman *et al*., 2004; Colombo *et al*., 2005; Bergmann *et al*., 2006; Birol and Cox, 2007). In the choice experiment presented here, two ecological and two social and economic attributes were selected to reflect the variety of economic benefits 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 provided by the wetland, and the social values associated with re-training locals in environmentally friendly employment. Many species of animals, plants and their habitats depend on wetlands for their continued existence. To date the majority of the economic values associated with wetlands have been attributed to biodiversity (see, for example Brouwer *et al*., 2003; Brander *et al*., 2006). Open water surface areas and the natural vistas

Table 11.1 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 (OWSA)	The surface area of the lake that remains uncovered by reed beds.	Low: Decrease from the current open water surface area of 20% High: Increase open water surface area to 60%
Research and education	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 opportunities High: Improve the level of educational and research opportunities by providing better facilities
Retraining of farmers	Re-training of local farmers in environmentally friendly employment such as eco-tourism and arid-crop production.	Number of farmers re-trained in environmentally friendly employment: 30, 50, 75, 150
Payment	A one-off payment to go to the 'Cheimaditida Wetland Management Fund'.	Four payment levels from the pilot CV: €3, €10, €40, €80

associated with them are expected to create benefits through feelings of serenity and tranquillity. Further, higher open water surface areas provide the water quantity required for sustaining the wetland's biodiversity. Research and educational opportunities from the wetland are expected to contribute to social and economic values associated with cultural heritage and scientific knowledge. Finally, re-training locals in environmentally friendly employment is expected to generate social and economic values for the wider public.

The fifth attribute included in the choice experiment is a monetary one, which is required to estimate welfare changes. The levels of the monetary attribute used in the CE and the payment vehicle employed were determined through an open-ended pilot contingent valuation survey (Birol *et al.*, 2006b). The payment vehicle was a one-off increase in taxes for the year 2006–2007 to be channelled to a 'Cheimaditida Wetland Management

Fund', which would be managed by a trustworthy and independent body. Taxation was preferred over voluntary donations since respondents may have the incentive to free-ride with the latter (Whitehead, 2006), a point which was also brought up by the focus group participants, who did not reveal any major objections to the payment vehicle employed. The payment levels used are €3, €10, €40 and €80.

A large number of unique wetland management scenarios can be constructed from this number of attributes and levels.[3] Experimental design techniques (see Louviere *et al*., 2000) and SPSS Conjoint software were used to obtain an orthogonal design, which consisted of only the main effects, and resulted in 32 pair-wise comparisons of alternative wetland management scenarios. These were randomly blocked to four different versions, each with eight choice sets. Each set contained two wetland management scenario profiles and an option to select neither scenario. Such an 'opt out' option can be considered as a status quo or baseline alternative, whose inclusion in the choice sets is instrumental in achieving welfare measures that are consistent with demand theory (Louviere *et al*., 2000; Bennett and Blamey, 2001; Bateman *et al*., 2003). The respondents were told that if they chose the 'opt-out' option, they would not be expected to pay, but there would not be any active wetland management, in which case the condition of the wetland would deteriorate to low levels for the biodiversity, open water surface area and research and education attributes (as defined in Table 11.1), and no locals would be re-trained in environmentally friendly employment. An example of a choice set is presented in Figure 11.1.

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, eight small towns (Amyntaio, Ptolemaida, Florina, Edessa, Kozani, Veroia, Naoussa, Chalkithona) and two cities (Athens and Thessaloniki) were selected. These locations were chosen to represent a continuum of distances from the Cheimaditida Wetland, as well as rural and urban populations. This design encompasses 60 per cent of the Greek adult population, with a sampling frame of 5 383 560. 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 the changes in conditions of the Cheimaditida Wetland.

In the second stage, randomly selected individuals were surveyed in each of the city and town centres. 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

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 deteriorate to low levels for biodiversity, open water surface area and research and education attributes, and no locals would be retrained.

	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 ☐

Figure 11.2 Sample choice set

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 research and were combined artificially, and each attribute was defined to ensure uniformity in understanding. A total sample of 700 respondents was envisaged, distributed between the 10 locations proportionately to their population levels. Across the 10 locations, overall 58 per cent of the sample approached agreed to take part in the survey, and a total of 407 respondents were interviewed.

In addition to the choice experiment questions, data on the respondents' social and economic characteristics and environmental attitudes were collected. This information is required to assess the representativeness of the sample of the Greek public, as well as to use these data as explanatory variables to investigate heterogeneity in preferences. The descriptive statistics of the sample reveal that the social and economic characteristics of the sample are similar to those of the Greek population with the exception of income, employment, the percentage of respondents with children, and education. The first 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.

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

THEORETICAL FRAMEWORK

As mentioned in the other chapters of this volume, the choice experiment approach has a theoretical grounding in Lancaster's model of consumer choice (Lancaster, 1966), and an econometric basis in models of random utility (Luce, 1959; McFadden, 1974). Lancaster proposed that consumers derive satisfaction not from goods themselves but from the attributes they provide. 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 and an error component, which is independent of the deterministic part and follows a predetermined distribution. The error component implies that predictions cannot be made with certainty. Choices made among alternatives will be a function of the probability that the utility associated with a particular option is higher than that associated with other alternatives.

Earlier applications of the approach assumed homogeneous preferences across respondents, though preferences are in fact heterogeneous. Accounting for heterogeneity, however, enables unbiased estimates of individual preferences, enhancing the accuracy and reliability of estimates of demand, participation and marginal and total welfare (Greene, 1997). Furthermore, accounting for heterogeneity enables the prescription of policies that take equity concerns into account. Information on who will be affected by a policy change and the aggregate economic value associated with such changes is necessary for making efficient and equitable policies (Boxall and Adamowicz, 2002).

As explained in Chapter 7, the latent class model (LCM) is one of the most recent models to be employed to investigate preference heterogeneity. The LCM casts heterogeneity as a discrete distribution, a specification based on the concept of endogenous (or latent) preference segmentation (Wedel and Kamakura, 2000). The approach depicts a population that consists of a finite and identifiable number of segments, or groups of individuals. Preferences are relatively homogeneous within segments but differ substantially from one segment to another. The number of segments is determined endogenously by the data. Belonging to a specific segment is probabilistic, and depends on the social, economic and demographic characteristics of the respondents, as well as their perceptions and attitudes with regard to environmental goods and resources. Respondent characteristics affect choices indirectly through their impact on segment membership.

Formally, in the LCM employed here, the utility that the respondent i, who belongs to a particular segment s, derives from choosing wetland management scenario alternative $j \in C$ can be written as

$$U_{ij/s} = \beta_s X_{ij} + s_{ij/s}, \tag{11.1}$$

where X_{ij} is a vector of attributes associated with wetland management scenario alternative j and respondent i, and β_s is a segment-specific vector of taste parameters. The differences in β_s vectors enable this approach to capture heterogeneity in preferences for the wetland management scenario attributes across segments. Assuming that the error terms are identically and independently distributed (iid) and follow a Type I (or Gumbel) distribution, the probabilistic response function is given by:

$$P_{ij/s} = \frac{\exp(\beta_s X_{ij})}{\sum_{h=1}^{C} \exp(\beta_s X_{ih})} \tag{11.2}$$

Consider a segment membership likelihood function M^* that classifies the respondent into one of the S finite number of latent segments with some probability P_{is}. The membership likelihood function for respondent i and segment s is given by $M^*_{is} = h_s Z_i + Q_{is}$, where Z represents the observed characteristics of the respondent, such as their social, economic and demographic characteristics, and their perceptions and attitudes. Assuming that the error terms in the respondent membership likelihood function are iid across respondent and segments, and follow a Gumbel distribution, the probability that respondent i belongs to segment s can be expressed as

$$P_{is} = \frac{\exp(h_s Z_i)}{\sum_{k=1}^{S} (h_k Z_i)}, \tag{11.3}$$

where $h_k (k = 1,2, \ldots S)$ are the segment-specific parameters to be estimated. These denote the contribution of the various respondent characteristics to the probability of segment membership. A positive (negative) and significant h implies that the associated respondent characteristic, Z_i, increases (decreases) the probability that the repondent i belongs to segment s. P_{is} sums to one across the S latent segments, where $0 \leq P_{is} \leq 1$.

In order to derive a mixed-logit model that simultaneously accounts for wetland management scenario choice and segment membership, (11.2) and (11.3) are brought together. The joint probability that respondent i belongs to segment s and chooses wetland management scenario alternative j is given by:

$$P_{ijs} = (P_{ij/s})*(P_{is}) = \left[\frac{\exp(\beta_s X_{ij})}{\sum_{h=1}^{C} \exp(\beta_s X_{ij})}\right] * \left[\frac{\exp(h_s Z_i)}{\sum_{k=1}^{S} \exp(h_k Z_i)}\right]. \qquad (11.4)$$

RESULTS

As explained above, the LCM assumes that respondent characteristics affect choice indirectly through their impact on segment membership. After extensive testing with the respondent characteristics that were collected in the survey, the variables that affect segment membership the most were found to be the education level of the respondents, their environmental attitudes (that is, the ECI), income, distance to the wetland, whether they have children and if they visited the wetland in the past. The LCM was estimated using LIMDEP 8.0 NLOGIT 3.0, and models with two, three and four segments were run. The log likelihood, $\bar{\rho}^2$, Bozdogan Akaike Information Criterion (AIC3) and Bayesian Information Criterion (BIC) statistics for these LCMs are reported in Table 11.2.

Determination of the optimal numbers of segments requires a balanced assessment of the statistics reported in Table 11.2 (Louviere *et al.*, 2000; Wedel and Kamakura, 2000; Andrews and Currim, 2003). The log likelihood decreases and $\bar{\rho}^2$ increases as more segments are added, supporting the presence of multiple segments in the sample. The BIC and AIC3 statistics decreases monotonically as the number of segments increases but all four statistics flatten out from the two-segment model. Both AIC3 and BIC

Table 11.2 Criteria for determining the optimal number of segments

No. of Segments	**Log likelihood**	$\bar{\rho}^2$	**Parameters (P)**	**AIC3**	**BIC**
1	−3325.7	0.07	6	6669.4	3343.7
2	−2538.98	0.29	18	5131.96	2593.07
3	−2428.2	0.321	30	4946.4	2518.35
4	−2423.8	0.322	42	4973.6	2550.01

Note: AIC3 (Bozdogan AIC) is $(-2LL+3P)$; BIC(Bayesian Information Criterion) is $-LL+(P/2)*ln\ (N)$.

statistics are minimised at three segments, indicating a three-segment model as the optimal solution. It has, however, been demonstrated that the AIC3 and BIC criteria never under-fit the number of segments but sometimes over-fit, and over-fitting the true number of segments produces larger parameter bias than under-fitting (Andrews and Currim, 2003). Therefore the two-segment model provides the best fit to the data.

The results of the two-segment model are reported in Table 11.3. The first part of the table displays the utility coefficients from wetland management attributes and the second part reports segment membership coefficients. The segment membership coefficients for the second segment are normalised to zero in order to identify the remaining coefficients of the model. All other coefficients are interpreted relative to this normalised segment. For segment 1 the utility coefficients for all of the four wetland attributes are significant, indicating that respondents in this segment prefer wetland management which provides higher levels of each one of these attributes.

Table 11.3 Two-segment LCM estimates for wetland management attributes

	Segment 1	**Segment 2**
Utility function: Wetland management scenario attributes		
ASC	2.4*** (0.095)	—1.19*** (0.17)
Biodiversity	0.27*** (0.026)	0.08 (0.08)
OWSA	0.16*** (0.028)	0.29*** (0.085)
Research and education	0.14*** (0.027)	—0.08 (0.08)
Re-training	0.003*** (0.0007)	0.003** (0.0019)
Payment	—0.015*** (0.001)	—0.042*** (0.005)
Segment function: Respondents' social and economic characteristics		
Constant	—0.38 (0.37)	-
Education	0.44** (0.25)	-
ECI	0.06* (0.035)	-
Income	0.0002** (0.0001)	-
Child	0.25 (0.27)	-
Visit	0.005 (0.3)	-
Distance	0.004*** (0.001)	-
Log likelihood	2538.98	
p^2	0.29	
Sample size	3256	

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

Source: Cheimaditida Wetland Management Choice Experiment Survey, 2005

The segment membership coefficients for this segment reveal that higher income, ECI, distance from the wetland and having a university degree increase the probability that the respondent belongs to the first segment, For the second segment, the biodiversity and research and education attributes are insignificant determinants of choice, whereas the other two attributes, that is, open water surface area (OWSA) and re-training of locals in environmentally friendly employment increase the likelihood that respondents in segment 2 choose a wetland management scenario with higher levels of these attributes.

The relative size of each segment is estimated by inserting the estimated coefficients into equation (11.3). This provides the series of probabilities that each respondent belongs to either one of the two segments. The respondents are assigned to one of the segments on the basis of their largest probability score. It is found that the majority of the sample, 57.24 per cent, belong to the first segment and 42.76 per cent belong to the second segment. The descriptive statistics for the social, economic and attitudinal characteristics of each segment are reported in Table 11.4.

As expected, respondents in segment 1, who derive significant and positive values from all four of the wetland management attributes, have statistically significantly higher levels of income, ECI, education and full-time employment. A higher proportion of respondents in segment 1 have children, and they also have a higher number of dependent children in the household, revealing ‘bequest motives’ (Krutilla, 1967) as found by previous wetland valuation studies (for example, Kosz, 1996). Finally, respondents in segment 1 live significantly closer to the wetland than those in segment 2, thereby revealing distance decay for valuation of this environmental resource, similar to the results of previous wetland valuation studies (for example, Bateman *et al.*, 1995).

Estimation of Willingness To Pay (WTP)

As explained in the previous chapters, the choice experiment method is consistent with utility maximisation and demand theory (Bateman *et al.*, 2003), so when the parameter estimates are obtained by the use of the appropriate model, welfare measures can be estimated using the following formula:

$$WTP = \frac{\ln \sum_k \exp(V_k^1) - \ln \sum_k \exp(V_k^0)}{\beta_{monetaryattribute}} \qquad (11.5)$$

where WTP is the welfare measure, $\beta_{monetaryattribute}$ is the marginal utility of income represented by the coefficient of the monetary attribute in the CE,

Table 11.4 Profiles of respondents belonging to the two segments in LCM

Social and economic characteristics	Segment 1 N=233	Segment 2 N=174
Heard of the wetland	30.6%	31.2%
Visited the wetland*	13.7%	21.2%
ECI***	7 (3.5)	4.3 (3.2)
Gender***	61.5%	43.3%
Age	38.9 (13.4)	40.2 (15.3)
Household size***	3.6 (1)	2.9 (1.3)
Children***	67.6%	45%
Number of dependents***	1.2 (0.9)	0.6 (0.9)
Education***	88%	32.9%
Employment***	66.4%	57%
Tenure	80%	80.3%
Income***	2701.5 (1319.5)	1470.7 (735.2)
Distance **	193.1 (165.8)	241.2 (225.3)
Urban*	51.8%	46.3%

Note: T-tests and Pearson Chi square tests show significant differences (*) at 10% significance level; (**) at 5% significance level, and (***) at 1% significance level.

Source: Cheimaditida Wetland Management Choice Experiment Survey, 2005

and V^0_k and V^1_k represent indirect utility functions before and after the change in wetland management. For the linear utility index, the marginal value of change in a single binary wetland management attribute can be represented as a ratio of coefficients, reducing equation (11.5) to:

$$WTP = -\left(2\frac{\beta_{wetlandattribute}}{\beta_{monetaryattribute}}\right) \tag{11.6}$$

(see, Hu *et al.*, 2004) This part-worth (or implicit price) formula represents the marginal rate of substitution between income and the binary attribute in question, that is, the marginal WTP for a change in the attribute. As explained in Chapters 4 and 5, compensating surplus welfare measures can be obtained for different wetland management scenarios associated with multiple changes in attributes, that is, equation (11.5) simplifies to:

$$Compensating\ surplus = -(V^0 - V^1)/\beta_{monetaryattribute} \tag{11.7}$$

Table 11.5 reports the implicit prices, or marginal WTP values, for each of the wetland management attributes estimated using the Wald procedure (Delta method) in LIMDEP 8.0 NLOGIT 3.0.

Table 11.5 Marginal WTP for wetland management attributes (€/ respondent and 95% C.I.)

Attribute	Segment 1	Segment 2	Weighted
Biodiversity* **	17.8 (16.10–19.5)	-	7.7 (6.96–8.44)
OWSA* **	10.01 (8.25–11.88)	7.25 (5.13–9.38)	8.45 (6.48–10.46)
Research & education* **	9.1 (7.34–10.84)	-	3.93 (3.17–6.15)
Re-training (per person)* **	0.195 (0.149–0.24)	0.075 (0.03–0.12)	0.127 (0.066–0.172)

Note: T-tests show significant differences among at least one pair of models (*) at 10% significance level; (**) at 5% significance level and (***) at 1% significance level.

Source: Cheimaditida Wetland Management Choice Experiment Survey, 2005.

The implicit prices reported in Table 11.5 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 opportunities are 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 a high level; research and educational opportunities are 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 opportunities are 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 opportunities are high; and 150 local farmers are re-trained.

To obtain the CS associated with each of the above scenarios, the differences between the welfare measures under the status quo and the three management scenarios are calculated. 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.

Table 11.6 Compensating surplus for each scenario (€ / respondent)

Scenario	Segment 1	Segment 2	Weighted
1 - Low impact	170	57.75	107.59
2 - Medium impact	195.67	53.88	116.49
3 - High impact	220.3	66.75	134.46

Source: Cheimaditida Wetland Management Choice Experiment Survey, 2005.

The estimates of WTP for the three scenarios are reported in Table 11.6. For comparisons, CS estimates are calculated for all four models. As expected, the CS for the change from the status quo to the scenarios considered increases as we move towards improved ecological, social and economic conditions in the wetland. The mean WTP for the Low impact scenario is €107.59, whereas greater improvements in ecological, social and economic conditions in the wetland under the Medium impact scenario increase the mean WTP to €116.49, and under the High impact scenario to as high as €134.46.

Cost-Benefit Analysis

The results can be used to design socially efficient wetland management policies by estimating the cost of improving the different attributes of the 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 11.7. The total cost of providing the Low impact scenario is €500 872 per annum; the total cost of providing the Medium impact scenario is €6 314 179 per annum; and the total cost of providing the High impact scenario is €7 021 358 per annum.[4]

Further, the welfare estimates reported in Table 11.6 for the weighted LCM are aggregated over the entire sampling frame to determine the total WTP (that is, total benefits) for the three scenarios described above. Based on the fraction of the sample agreeing to take part in the survey (58 per cent), the aggregate WTP to achieve the ecological and social conditions described in the Low impact scenario is €335 852 335; in the Medium impact scenario the aggregate WTP is €363 735 948; and for the High impact scenario, this amounts to €419 846 644. 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 €335 351 463; €357 421 769 for the Medium impact scenario and €412 825 286 for the High impact scenario. Thus, the total net economic

Table 11.7 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	2 00 000
Research and education opportunities:	
1. Construction of a visitor centre	6 00 000
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' and profit and loss) of switching to non-irrigated crops[b]	1591.2 /ha/annum

Notes:
[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).

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

benefits of wetland management increase with the impact of the management scenario. However, it should be noted that the benefit estimates are likely to be upwards biased due to the hypothetical nature of the payment commitment (that is, hypothetical bias). Therefore the net benefits generated by the alternative management scenarios should be considered as upper bound values.

POLICY IMPLICATIONS AND CONCLUSIONS

This chapter contributes to the limited literature on estimation of economic values of water resources, more specifically wetlands, using choice experiments to inform policies on efficient and effective management of water resources. As explained in the literature review presented in Chapter 2, the study presented in this chapter is one of the growing number of choice experiments carried out in the EU to value water resources, and currently the only wetland valuation choice experiment carried out in Greece. This chapter has demonstrated that the choice experiment method can be successfully employed to inform management of water resources, which have both public and private good values.

More specifically, the results indicate that there are positive and significant economic benefits associated with the ecological, economic and social attributes of the case study wetland in this chapter, that is, the Cheimaditida Wetland located in Greece. The impacts of social, economic and attitudinal characteristics of respondents on their valuation of wetland management attributes are significant and conform with economic theory. The application of the latent class model, which is generally employed to estimate preference heterogeneity for valuation of private goods, as presented in Chapter 7, revealed that there is considerable preference heterogeneity within the public for management of this water resource, which is a public good. This heterogeneity should be taken into consideration to ensure social equity, as well as the stakeholder participation and consultation requirements of the European Union's Water Framework Directive (WFD).

The total benefits derived from various wetland management scenarios are aggregated over the sampling frame, and compared to their costs. The net benefit estimates reveal that social welfare maximisation is achieved under the High impact scenario of wetland management, which provides higher levels of ecological, social and economic attributes. With the use of the benefits transfer method or the value inference method presented in Chapter 9 of this volume, this study can provide policy makers with useful information for management of other similar wetlands in Greece, as well as in Europe, given the current mandate under the EU's WFD, as well as the Habitats and Birds Directives.

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NOTES

1. Katia Karousakis, Environment Directorate, Organisation for Economic Co-operation and Development. The views stated in the chapter do not necessarily represent the views of the OECD or its member countries.
2. For a detailed account of this choice experiment study, see Birol et al. (2006a).
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 $4^2*2^3=128$.
4. To estimate the annual profit or 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 or loss per farmer is 6762.39 (4.25 ×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 Opportunities high (600 000 + 84 000) + Re-training 150 farmers (98 000 + (6762.39 × 150))] = €7 021 358 for the first year.

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