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Athanasios Ragkos · Asimakis Psychoudakis
Argiro Christofi · Alexandros Theodoridis

Using a functional approach to wetland valuation: the case of Zazari–Cheimaditida

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Abstract This study proposes the valuation of wetland functions as an alternative to the conventional approach to wetland valuation, in order to derive indicators for decision-making in wetland management. It is illustrated that these functions can be valuated in terms of the goods and services they provide to society. Using a functional approach, the functions are identified and the goods and services they provide are explicitly allocated among them; then, the latter are valuated with the Contingent Valuation method. Statistical analysis of the data provides welfare measures that reflect the value of these functions. It is argued that the values of separate functions are more useful in policy-making than their aggregated value.

Keywords Wetlands · Ecosystem goods and services · Contingent valuation · Functional approach

Introduction

Effective wetland management is steadily gaining attention in the environmental policy agenda and has been endorsed by the Water Framework Directive (2000/60/*E*C). Central to the development of effective management schemes, which achieve optimal resource use, is the valuation of wetland ecosystems in order to quantify benefits extracted from their direct and indirect use. A precise approximation of a wetlands' economic value is therefore essential, but it entails the valuation of unrecognized goods and services, which are often endowed with public-good characteristics.

Wetland valuation studies are extensively available in literature; however, the majority focuses on a single or a restricted number of goods and services. Reference is made to Bateman et al. (1995), Steever et al. (1998), Azavedo et al. (2000) and Loomis et al. (2000). These studies employ the Contingent Valuation (CV) method to evaluate one or more of the following wetland values: amenity and recreational value; aesthetic value; provision of habitat value and flood control value. Sample sizes, survey methodologies and elicitation formats vary across studies. Brouwer et al. (1999) provide a meta-analysis of wetland CV studies carried out in the USA, Canada and Europe and estimate the value of few wetland functions.

The attribution of monetary values to the functions performed by wetland ecosystems constitutes an alternative approach to wetland valuation. Functional performance provides goods and services that are of value to society, therefore the value of these functions reflects human preferences for sets of goods and services for which there is demand. Although it is difficult to value wetland functions, as there is no direct demand for them, it is plausible to value their corresponding goods and services. A functional approach of wetland ecosystems (National Research Council 1996; Bergstrom et al. 1996) is a useful tool for this purpose. A functional approach proposes a holistic examination of a wetland by allowing the identification of all the functions performed by the ecosystem, as well as the goods and services these functions provide. The derived indicators of wetland function values can be incorporated into wetland management scenario assessment frameworks, as they indicate the impact of management schemes to human welfare.

This study proposes an indirect methodology for valuing wetland functions in terms of the goods and services they provide and demonstrates an application to Zazari–Cheimaditida wetland in Greece. First, all wetland-related goods and services are identified and allocated among functions with a functional approach of the wetland ecosystem. Then, values are assigned to these goods and services using the CV approach, an environmental stated-preference valuation technique. With this

A. Ragkos (✉) · A. Psychoudakis · A. Christofi · A. Theodoridis
Department of Agricultural Economics, School of Agriculture,
Aristotle University of Thessaloniki, P.O. Box 232,
54 124 Thessaloniki, Greece
E-mail: tragos@agro.auth.gr
Tel.: +30-2310-998826
Fax: +30-2310-998828

method, respondents' stated Willingness To Pay (WTP) is used to estimate welfare measures for wetland functions. Effective survey design is essential to accurately estimate the values of all goods and services attributable to wetland functioning.

The paper unfolds as follows. Section ''Valuation of wetland functions'' provides an overview of basic features of wetlands and the methodological framework for functional valuation. Section ''Zazari–Cheimaditida catchment'' presents Zazari–Cheimaditida catchment and the functional approach of the ecosystem. Sections ''Survey design'' and ''Model specification-derivation of welfare measures'' discuss survey design and statistical analysis issues. Section ''Results'' reports the results of the analysis. Finally, Sect. ''Conclusions—policy implications'' includes the conclusions and discusses policy implications.

Valuation of wetland functions

The economic valuation of the environment is based on public perceptions upon ecosystem performance. In this context, it is substantial to define wetland features that are important to society. Among a wide variety of definitions, this study adopts the one introduced by Turner et al. (2000). According to them, interactions among wetland characteristics, structure and processes result in the performance of functions, which are not of economic nature but provide a flow of goods and services which are valued by society. These values are due to direct or indirect use of such goods and services (direct use and indirect use values) or are independent of use (non-use values). Non-use values include existence value (the value that an individual places on a wetland only by knowing that it exists), option value (the satisfaction of knowing that the wetland will be available in the future) and bequest value (the wetland will supply future generations with goods and services). The aggregated values of wetland goods and services constitute the total economic value of the wetland.

The valuation of wetland ecosystems is basically the attachment of monetary values to goods and services they provide. Consequently, as wetland functions constitute the primary sources of the flow of goods and services, their valuation is an intriguing task. Given the ecological nature of these functions, direct valuation is not possible; instead, they can be valued indirectly in terms of the goods and services they provide. This study proposes a functional approach of the wetland to identify all the functions performed by the ecosystem as well as the goods and services that these functions provide to society and a CV survey to attach monetary values to related goods and services. With this approach, the values of wetland functions are derived as the aggregated values of the goods and services they provide.

A functional approach is necessary for valuing wetland functions, as it allows for a holistic examination of wetland ecosystems, which mitigates the problem of understatement or omission of certain goods and services. This is a lingering issue when it comes to valuing all components of an environmental asset (see Dupont 2003; Veisten et al. 2004; Parry-Dziegielewska and Mendelsohn 2005). Maltby et al. (1999) argues in favour of a functional approach, as it allows for efficient natural and financial resource use by determining relationships between human activities and ecosystem functions. Nonetheless, it is not restricted to an examination of resource conservation; it rather recognizes a wide range of ecological and environmental interactions. This approach allows the identification of all functions and of interactions among them, the recognition of all goods and services provided by functional performance and their explicit allocation among functions. The latter is complicated when it comes to goods and services that derive from the performance of two or more functions. Such goods and services are divided into ''sub-goods'' and ''sub-services'' and are then attributed to the corresponding functions. This is an arbitrary distinction and is only undertaken for the purpose of functional valuation.

The employment of the CV method in this survey is due to its applicability to the estimation of use and non-use values of non-marketed wetland goods and services. This stated-preference technique is based on the formulation of a hypothetical market and on the use of a questionnaire to survey a sample in order to elicit respondents' WTP for an asset. The CV method has been criticized as to whether estimated values reflect actual WTP, due to the hypothetical nature of the method (Brown et al. 2003) and several other potential biases, such as strategic behaviour and embedding effects (Kahneman and Knetsch 1992). These issues have been discussed in a considerably large body of literature (for example see Diamond and Hausman 1994; Carson 2000). A common suggestion is that the inherent disadvantages of the method can be effectively mitigated by careful survey design. The NOAA Panel's Report (Arrow et al. 1993), consisting of Nobel-laureates, provides such guidelines in order to yield reliable monetary estimates for use in cost–benefit analysis.

The monetary values of wetland functions are useful in assessing wetland management schemes, as they reveal public preferences on wetland management; therefore, they induce the adoption of management schemes that promote highly valued wetland functions. Monitoring changes in the value of wetland functions, due to specific management practices, is counterpart to forecasting changes in the values of corresponding goods and services. Alternatively, separate examination of wetland goods and services would be possible only for a limited number and considerably time-consuming whatsoever. Notwithstanding its considerable advantages, this assessment framework requires a detailed examination of wetland ecosystems, including hydrological, biological and biochemical data in order to capture all possible implications of interventions on wetland functions.[1]

Zazari–Cheimaditida catchment

Zazari–Cheimaditida catchment is situated in North-West Greece. Total acreage of the lakes is 11,400 ha; the remaining area includes forests, rangelands and farmland. The catchment is included among Less Favoured Areas of Greece. Locals are mainly employed in agriculture, the public sector and fishery. Arid crops include winter cereals, while the main irrigated crops are sugar beet, lucerne, maize and potatoes. Agrochemical use is moderate; however water extraction for irrigation is heavy and is steadily increasing.

The ecosystem is included in ''NATURA 2000'' web and is cited in Corine Biotope Project. More than 150 plant species have been reported in the area, while local fauna is also of great importance, especially endangered bird species such as *Pelecanus crispus* (Dalmatin Pelican), *Aythya nyroca* (Ferriginous Duck), *Falco naumanni* (Lesser Kestrel) and *Circus pygargus* (Montagu's Harrier), many of which are protected by international conventions and EU regulations. However, environmental degradation is visible as meadows have been reduced, open water surface has diminished, reed bed is constantly expanding and water quality has been reduced. These conditions affect adversely natural habitats and commercial fish populations.

A functional approach of the wetland has identified five wetland functions. The performance of these functions depends on a range of factors such as the type and the site of the wetland, its substratum, the origin, depth and chemical composition of the water, vegetation types, diversity of habitats, etc. The functions and the goods and services provided by each one of them are presented below.

- Groundwater recharge function involves the recharge of groundwater by infiltration and percolation of detained floodwater into a significant aquifer. Groundwater is endowed with existence, option and bequest values, while its actual uses include provision of household water, irrigation, livestock and wildlife watering and treatment of wastewater through surface water supplies.
- Floodwater retention function is the short- or long-term detention and storage of waters from overbank flooding and/or slope runoff and their gradual release, so as to reduce peak flow. Flood and corrosion control is of value for protected assets and resources such as natural habitats, crops and fields that abut onto the lakes, and buildings.
- Sediment retention function involves the net retention of sediments (nutrients, heavy metals or agrochemical residues), carried in suspension by slowly moving waters inundating the wetland, by runoff from the contributory area, by precipitation and/or by the wind. The main service of this function is water quality maintenance, which constitutes a natural substitute for water purification facilities, generates recreational activity, preserves fish stocks and is important for locals' health. Related to this function are also mitigation of damage of water conveyance facilities and soil enrichment with nutrients, unless fertility is decreased by silt deposition.
- Nutrient export function is the removal and/or transformation of excess nutrients (nitrogen and phosphorus) from a wetland via biological, biochemical, physical and land management processes. Excessive nutrient concentration accelerates eutrophication, which is the cause of turbidity and oxygen deficiency. The predominance of such conditions entails increased vegetation, reed bed expansion, loss of habitats and of biodiversity, including commercial fisheries, unsuitable water for consumption and decrease in amenity value.
- Food web support function includes the support of food webs within and outside a wetland through the production of biomass and its subsequent accumulation and export. Of these, it is only anthropogenic biomass export that is of economic importance. This biomass, such as timber, can be commercially exploited, may support recreational activities or could be of subsistence and option values. The wetland also provides habitat and food to species, thereby generating considerable biodiversity.

Survey design

The CV survey for the valuation of wetland functions was conducted using a carefully designed questionnaire, following the NOAA panel's guidelines. The final version of the questionnaire was formulated after a pilot survey with open-ended WTP questions. The questionnaire consists of three parts (Mitchell and Carson 1989), of which the first asks general questions, the second presents WTP questions and the third includes respondents' socio-economic characteristics.

The first part of the questionnaire aims at recording respondents' attitudes towards the wetland and particularly their belief in the feasibility of wetland function restoration. Along with these questions, respondents are presented with a list of environmental characteristics and activities and are asked to indicate the ones related to the wetland.

In the second part, an introductory text explains the purpose of the survey and presents the scenario for the restoration of functions. This scenario involves the construction of technical works, described by Lazaridou et al. (2001). At the time of the survey, locals were

[1] A tool for the assessment of wetland functions and for predictions on functional performance under alternative management scenarios has been developed in EVALUWET, an integrated EU project. Central to this are the Functional Assessment Procedures (Jannsen et al. 2005).

already aware of the planned interventions, so it is reasonable to assume that respondents would consider the scenario adequately realistic. The presentation of the scenario is quite detailed, however technical aspects were omitted.

Functions are described to respondents in separate texts. Information in these texts involves all relevant goods and services, the situation of non-provision of goods and services due to loss of functions, and of functional performance at an ideal level, which corresponds to the restoration scenario. Special care is taken to formulate detailed, realistic and comprehensive descriptions; for this purpose, the first draft of the texts was pre-tested during the pilot survey.

The questionnaire includes six WTP questions; the first five concern WTP for separate functions and the sixth WTP for all functions. Successive valuation of assets is subject to question order bias (Carson and Mitchell 1995), connected mainly to substitution and income effects. To avoid such bias, the order of WTP questions for separate functions is varied across five alternative versions, each one of which included equal numbers of questionnaires. In each question, respondents are asked to place a value on a function, regardless payments for other functions. Furthermore, respondents are reminded that such payments may constrain their annual incomes.

The payment vehicle is an annual increment in municipal taxes. Taxation is incentive-compatible for referendum votes (Mitchell and Carson 1989), it minimizes "warm glow" effects (Kahneman and Knetsch 1992), it simulates real-life provision of public goods and it is applicable to non-use values (Burgess 2000). A tax of local interest, in particular, ensures respondents that their money will be directed towards their local community and will not be scattered through bureaucracy. Finally, an annual payment reflects the constant flow of wetland benefits and is preferred to an one-off payment.

The WTP question is preceded by a payment principle, where respondents are asked if they are willing to pay any amount for the restoration of a wetland function. A follow-up question to "no" answers aims at identifying protest votes.[2] A "yes" answer is followed by a Discrete-Choice (DC) WTP question. This simulates consumers' decision-making process for real-world transactions and reduces strategic behaviour (Hoehn and Randall 1987). Careful bid selection is of crucial importance for this question format. In this study, bids were determined based on the results of the pilot survey; their frequency of appearance depends on their observed frequency in the pilot survey.

The main survey was conducted with in-person interviews on a sample of 210 respondents, 13.3% of which refused to participate to or complete the survey. Careful examination of data ruled out the use of additional eight questionnaires, hence valid sample size was 174. Protest votes to one or more valuation questions were then detected and removed. Table 1 presents the number of protest votes and data set sizes.

[2]Protest votes are present when respondents who might place a non-zero value to a function state zero WTP because of disagreement to the payment vehicle. For this reason, such votes are removed from the sample. A "no" answer to the payment principle is considered a protest vote if the respondent believes that the state is responsible for financing the restoration.

Model specification-derivation of welfare measures

- The theoretical framework for this analysis of DC CV data is based on the construction of a statistical model with utility-theoretic considerations (Hanemann 1984, 1989). Welfare measures are derived based on the estimation of the survival function of WTP, whose form depends on the particular form of the underlying utility function. The employment of the linear utility function yields a logit model, where the dependent variable is the probability that a respondent accepts the payment of a certain bid, and the independent variables are the bid amount and the respondent's socio-economic characteristics. Of various models, the most consistent results were derived by the following, which was estimated separately for the five functions and for all functions as a whole:

$$\mathrm{Log}[P(\mathrm{Yes})/1-P(\mathrm{Yes})] = B_0 + B_1(\mathrm{Bid}) + B_2(\mathrm{Gender}) + B_3(\mathrm{Age}) + B_4(\mathrm{Income}) + B_5(\mathrm{Education}) + B_6(\mathrm{Resident})$$

where P("Yes") and [1-P("Yes")] are the probabilities that a respondent accepts or rejects the payment of a certain bid, respectively.

- B_0 is the intercept term, and B_1, B_2, B_3, B_4, B_5, B_6 are the variable coefficients.
- "Bid" is the bid amount. There are eight bid levels for separate functions and five bid levels for all functions as a whole. The expected sign of the coefficient is (-), as respondents are bound to reject a payment as it gets higher.
- "Gender" is a nominal variable. There are no a priori indications for its expected sign (Teal and Loomis 2000).
- The expected sign of the coefficient of variable "Age" is (+), as indicated by Nunes and Schokkaert (2003).

Table 1 Survey response rate and protest votes

Wetland functions	Sample size	Valid responses	Protest votes	Data set size
Groundwater recharge	210	174	10	164
Floodwater retention	210	174	13	161
Sediment retention	210	174	10	164
Nutrient export	210	174	11	163
Food web support	210	174	11	163
All functions	210	174	3	171

- "Income"—The expected sign is (+), which means that lower income respondents are less bound to accept the payment of a certain bid than respondents with higher incomes. This is consistent with rational consumer behaviour and income constraints.
- "Education"—Years that the respondent has received education.
- "Resident"—The place of the respondent's permanent residency (local or non-local resident). A negative sign is expected, as locals are direct users of the wetland and are expected to be willing to pay more.

The results of the estimation of logit models can be used to generate welfare measures. This study focuses on mean WTP, which is the expected value of the random WTP variable. Using the above logit models, the mean of the non-negative WTP random variable (as is logical for an improvement) is calculated using the following formula (Loomis et al. 2000):

$$\text{Mean WTP} = (1/B_1)\ln(1 + e^{B})$$

where B is the sum of the intercept term B_0 plus the sum of products of the mean values of all variables other than "Bid" times their respective coefficients.

Confidence intervals for the estimated mean WTP are derived using the bootstrapping technique of Krinsky and Robb (1986). This entails the simulation of the unknown distribution of the random WTP variable by randomly drawing 10,000 values from a multivariate normal distribution. The mean vector of this distribution is the vector of the estimated logit coefficients and the variance–covariance matrix is the variance–covariance matrix calculated for each model.

Results

The descriptive analysis of responses to the introductory questions indicates that wetland protection is considered very important by 97.0% of the respondents. The vast majority (75.3%) has noticed wetland degradation during past years, and 73.0% believe that restoration is workable. It is worth to notice that some respondents spontaneously referred to the survey's restoration scenario.

Table 2 shows respondents' perceptions of wetland benefits. The majority link benefits such as the provision of irrigation water, game stocks, fish populations and fresh air to the wetland's existence, except for the provision of potable water (29.3%). Presumably, this is due to lack of information on possibilities of using groundwater for urban water provision. The preservation of the ecosystem's ecological balance, including the protection of flora and fauna and of food webs, is attributed to the wetland's existence by 92.0% of the respondents. Respondents also acknowledge linkages between the wetland and landscape quality, as well as recreation potential, especially alternative tourism. Following these observations, respondents are considered well-informed, which increases the reliability of the results.

Table 2 Respondents' perceptions of wetland goods, services and activities

Benefits	Yes (%)	No (%)	Do not know (%)
Irrigation water	78.7	19.5	1.7
Fisheries	86.2	12.1	1.7
Landscape enhancement	90.2	9.8	–
Flood control	69.0	25.3	5.7
Ecological balance	92.0	6.9	1.1
Forestry	69.0	24.1	6.9
Tourism	67.9	31.0	1.1
Potable water	29.3	64.9	5.7
Game stocks	63.8	32.2	4.0
Fresh air	81.0	17.2	1.8

Logit models

Table 3 presents the estimated logit models. The coefficient of "Bid amount" is negative, which reveals a strongly negative relationship between WTP for a certain bid and this bid amount, and significant at the 1% level in all models. Conversely, the coefficient of "Income" variable is also significant at the 1% level for all models, but its positive sign implies increasing WTP for higher incomes. The positive sign of coefficient of variable "Age" implies increasing WTP for older respondents; nevertheless, these coefficients are not significant at the 5% level in three models. The coefficients for "Years of schooling" and "Permanent resident" variables are positive and negative, respectively, for all models, which implies that WTP increases for well-educated people and local population, but, in most models, these coefficients are not significant at the 5% level. Finally, the negative coefficient of "Gender" variable for food web support function, although significant at a very low level, points to lower WTP for women than men; the opposite applies for the positive sign for the other models. McFadden R^2 and likelihood ratio test coefficients are satisfactory for all models; however they are lower for the model for all functions than for models for separate functions.

Estimation of mean WTP

Table 4 shows estimated mean WTP for separate wetland functions as well as for all functions, and their 95% confidence intervals. Mean WTP for nutrient export function is the highest, which reveals respondents' particular interest in prevention of eutrophication. This result is also due to the visibility of goods and services provided by this function. Not surprisingly, mean WTP for groundwater recharge function is also high as locals are specifically interested in groundwater availability for irrigation. Mean WTP for floodwater retention is

Table 3 Results of maximum likelihood estimation (logit models)

	Wetland functions					
	Floodwater retention	Food web support	Groundwater recharge	Nutrient export	Sediment retention	All functions
Intercept	−0.8278	1.8345	0.5198	-0.7875	−1.4762	−2.0123
	(−0.5747)	(1.1709)	(0.3446)	(−0.6246)	(−1.0244)	(−1.7881)
Bid	−0.0830**	−0.1232**	−0.0908**	−0.0599**	−0.1054**	−0.0159**
	(−5.1234)	(−5.7037)	(5.3728)	(−4.1310)	(5.3503)	(−3.5333)
Gender	1.7054*	−0.3570	1.5379	1.5668*	2.0454*	0.9328
	(2.0894)	(0.4818)	(1.8583)	(2.2370)	(2.4910)	(1.7255)
Age	0.0244	0.0400*	0.0218	0.0205	0.0675**	0.0489**
	(1.2727)	(1.9704)	(1.2247)	(1.1648)	(3.0269)	(3.0373)
Income	0.4251**	0.3709**	0.4211**	0.3612**	0.3750**	0.3072**
	(3.0451)	(2.6120)	(3.1829)	(3.0689)	(2.8259)	(3.1900)
Education	0.1080	0.1740*	0.0380	0.0474	0.1246	0.1236*
	(1.5429)	(2.0592)	(0.5330)	(0.7171)	(1.6140)	(2.1234)
Resident	−1.5694	−1.7163	−1.4796	−1.3421	−2.4696**	−1.9422**
	(1.8854)	(1.9223)	(1.9151)	(1.9530)	(2.8810)	(−3.0423)
Likelihood ratio test	60.5493	68.9603	57.5713	38.8452	59.8392	39.2946
McFadden R^2	0.324	0.395	0.305	0.203	0.343	0.173

Numbers in parentheses are *t*-statistics
*Significant at the 5% level
**Significant at the 1% level

relatively low, due to the rareness of flooding incidents. This is emphasized by the fact that only 69.0% of the respondents attribute flood control to wetland functioning (Table 2). Sediment retention is valued relatively low by respondents; this is also the case for ‘‘food web support’’ function as respondents are wary of flora and fauna protection projects.

An interesting result in Table 4 is the apparent difference between the sum of WTP for separate functions (211.30€) and WTP for wetland functions as a whole (125.82€). This divergence implies embedding effects, which is somehow expected as the value of assets is expected to be higher if valued independently than if they are part of a broader policy package (Randall and Hoehn 1996). Furthermore, it confirms that respondents ignored payments for other functions in valuing separate functions as requested. Apart from these arguments, there are four additional possible reasons for this result. First, bids for all functions are considerably higher than bids for separate functions, following the results of the pilot survey; therefore, income constraints might discourage respondents from accepting such high payments. Second, payments for all functions comprise considerably more goods and services—evidently not of the same value to all respondents—than separate functions. This increases respondents' uncertainty as to whether their payments will be directed to goods and services they are really willing to pay for. Third, considering that protest votes for all functions are fewer than protest votes for separate functions, it can be argued that the latter have been incorporated into ‘‘No’’ votes for bids for all functions. Fourth, the relatively low value of *M*cFadden R^2 coefficient for ‘‘all functions’’ model indicates that there are more underlying factors that determine consumers' behaviour towards such a payment.

Table 4 *M*ean WTP for wetland functions

Wetland functions	Mean WTP (€)	Confidence intervals (95%)	
		Lower bound (€)	Upper bound (€)
Groundwater recharge	43.30	37.70	52.89
Floodwater retention	42.53	37.11	55.38
Sediment retention	40.89	35.42	50.31
Nutrient export	44.43	35.77	65.24
Food web support	40.15	35.50	47.08
All functions	125.82	98.93	205.30

The above observations point out that monetary values of separate functions reflect preferences in a more consistent manner than WTP for all functions. The choice of the most appropriate welfare measure depends on the purpose of valuation. It is argued that separate values are useful in decision-making for optimal wetland rehabilitation strategies, while comparisons among wetlands to designate priority areas for protection could be based on the value of all functions. Because of the complex nature of wetland ecosystems, it can be assumed that the values of separate functions are not of importance, unless they are combined with the values of other functions. However, the value of a wetland function has a meaning in itself because it encompasses the aggregated values of goods and services that stem exclusively from it, while interactions among functions are captured by the introduction of ‘‘sub-goods’’ and "sub-services." Hence, an explicit classification of wetland goods and services, under a functional approach, is essential for such values to be of policy interest.

Conclusions—policy implications

The valuation of wetland functions is an alternative to wetland valuation studies up to date. This study proposes an indirect methodology for valuing wetland functions, based on a functional approach of a wetland ecosystem. This involves the identification of all wetland functions and of all the goods and services that they provide, as well as the introduction of "sub-goods" and "sub-services" when it comes to goods and services that stem from the interaction among functions. Wetland functions are evaluated in terms of the values of these goods and services, using the CV method, which is applicable to non-marketed goods and services and non-use values. Data from the CV survey yielded six data sets, five for the five wetland functions and an additional one for all functions.

Mean WTP for the restoration of wetland functions reflects the value that the public places on wetland functions. The results of this survey indicate that the sum of WTP for each function separately is considerably larger than WTP for all functions as a whole. It is argued that the values of separate functions provide a good approximation of public preferences, as the value of all functions is subject to income effects and uncertainties concerning the efficient use of funds.

The economic values derived from this survey reflect societal preferences and can be of use in policy-making, as the assessment of wetland management options can be based on these values. The results of such analyses are presented by Psychoudakis et al. (2005). Using cost–benefit analysis and multi-criteria analysis models it is illustrated that the optimal management strategy for Zazari–Cheimaditida is a no-intervention policy, unless a carefully budgeted management plan, including the construction of technical works, is introduced. Hence, based on the results of this survey it can be argued that "optimal" environmental protection can be achieved if the environmental benefits of policy packages exceed their financial costs.

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References

Arrow K, Solow R, Portney P, Leamer E, Radner R, Schuman H (1993) Contingent valuation methodology report, report of the NOAA panel on contingent valuation. Fed Regist 58:4602–4614

Azavedo C, Herriges JA, Kling CL (2000) Iowa wetland: perceptions and values. Staff report 00-SR 91. Center for Agricultural and Rural Development, Iowa State University, USA

Bateman IJ, Langford IH, Turner RK, Willis KG, Garrod GD (1995) Elicitation and truncation effects in contingent valuation studies. Ecol Econ 12:161–179

Bergstrom JC, Boyle KJ, Job CA, Kealy MJ (1996) Assessing the economic benefits of ground water for environmental policy decisions. Water Res Bull 32:279–291

Brouwer R, Langford IH, Bateman IJ, Turner RK (1999) A meta-analysis of wetland contingent valuation studies. Reg Environ Change 1:47–57

Brown TC, Ajzen I, Hrubes D (2003) Further tests of entreaties to avoid hypothetical bias in referendum contingent valuation. J Environ Econ Manage 46:353–361

Burgess D (2000) Determining society's values for programmes to improve the welfare of farm animals in the UK. PhD thesis, Queen's University Belfast

Carson RT (2000) Contingent valuation: a user's guide. Environ Sci Technol 34:1413–1418

Carson RT, Mitchell RC (1995) Sequencing and nesting in contingent valuation surveys. J Environ Econ Manage 28:155–173

Diamond PA, Hausman JA (1994) Contingent valuation: is some number better than no number? J Econ Perspect 8(4):45–64

Dupont DP (2003) CVM embedding effects when there are active, potentially active and passive users of environmental goods. Environ Resour Econ 25(3):319–341

Hanemann WM (1984) Welfare evaluations in contingent valuation experiments with discrete responses. Am J Agric Econ 66:332–341

Hanemann WM (1989) Welfare evaluations in contingent valuation experiments with discrete response data: reply. Am J Agric Econ 71:1057–1061

Hoehn JP, Randall A (1987) A satisfactory benefit–cost indicator from contingent valuation. J Environ Econ Manage 14:226–247

Jannsen R, Goosen H, Verhoeven ML, Verhoeven JTA, Omtzigt AQA, Maltby E (2005) Decision support for integrated wetland management. Environ Model Softw 20:215–229

Kahneman D, Knetsch JL (1992) Valuing public goods: the purchase of moral satisfaction. J Environ Econ Manage 22:57–70

Krinsky I, Robb AL (1986) On approximating the statistical properties of elasticities. Rev Econ Stat 68:715–719

Lazaridou T, Zalidis G, Papadimos D, Bilas G, Takavakoglou V, Katsavouni S (2001) Interventions for the rehabilitation of the functions of the Cheimaditida–Zazari wetlands. Greek Biotope/Wetland Centre, Thessaloniki, 232 pp

Loomis J, Kent P, Strange L, Fausch K, Covich A (2000) Measuring the total economic value of restoring ecosystem services in an impaired river basin: results from a contingent valuation survey. Ecol Econ 33:103–117

Maltby E, Holdgate M, Acreman M, Weir A (1999) Ecosystems management: questions for science and society. Royal Holloway Institute for Environmental Research, Virginia Water

Mitchell RC, Carson RT (1989) Using surveys to value public goods: the contingent valuation method. Resources for the Future, Washington

National Research Council (1997) Valuing ground water: economic concepts and approaches. National Academy, Washington

Nunes PALD, Schokkaert E (2003) Identifying the warm glow effect in contingent valuation. J Environ Econ Manage 45:231–245

Parry-Dziegielewska DA, Mendelsohn R (2005) Valuing air quality in Poland. Environ Resour Econ 30(2):131–163

Psychoudakis A, Ragkos A, Seferlis M (2005) An assessment of wetland management scenarios: the case of Zazari–Cheimaditida, Greece. Water Supply 5(6):115–123

Randall A, Hoehn JP (1996) Embedding in market demand systems. J Environ Econ Manage 30:369–380

Steever WJ, Callaghan-Perry M, Searles A, Stevens T, Svoboda P (1998) Public attitudes and values for wetland conservation in New South Wales, Australia. J Environ Manage 54:1–14

Teal GA, Loomis JB (2000) Effects of gender and parental status on the economic valuation of increasing wetlands, reducing wildlife contamination and increasing salmon populations. Soc Nat Resour 13:1–14

Turner RK, van der Bergh JCJM, Soderquist T, Barendregt A, van der Straaten J, Maltby E, van Ierland EC (2000) Ecological-economic analysis of wetlands: scientific integration for management and policy. Ecol Econ 35:7–23

Veisten K, Hoen HF, Strand J (2004) Sequencing and the adding-up property in contingent valuation of endangered Species: are contingent non-use values economic values? Environ Resour Econ 29(4):419–433