Local public's valuation of flood risk reduction, biodiversity conservation and recreational activities The polish case study

Ekin Birol, Nick Hanley, Phoebe Koundouri, Yiannis Kountouris

1. Introduction

As a result of climate change and significant wetland loss, floods have re-emerged as an important natural hazard concern in central and northern Europe during the last few decades. Global climate change and wetland loss are expected to increase the frequency and extent of floods in the future (Nichols *et al*. 1999). Increasing frequency and extent of floods in turn will cause significant changes in current land use and population patterns, and will impose significant economic damages. Even though floods in Europe have almost insignificant effects in terms of loss of human life, economic costs associated with flooding, such as damages to infrastructure and production, are high and ever-increasing.

In Poland the estimated costs of the damages of the floods of 1997 and 2001 are in the region of US $ 1 billion (Brakenridge *et al*. 1997, 2001). The Bobrek catchment in the Upper Silesia region of Poland is one of the regions in the country that is most susceptible to flooding, and the projected social, economic and environmental costs of predicted future flooding in this region are extremely high. The main reason for this region's high susceptibility to flooding is the centuries' long mining activities in this area, which has deformed its landscape. Paradoxically, land deformation caused by the mining industry and consequent floods have had a beneficial consequence ecologically. Unique ecological habitats have been formed in the flooded areas, harbouring important biodiversity riches that attract increasing scientific interest in terms of their conservation. In addition to the various economic values that these biodiversity-rich habitats generate (see, e.g., Pearce and Moran 1994), the wetland is also of high recreational value to local residents.

These habitats are, however, threatened by the current flood control policies, which do not prohibit the mining industry from deforming the landscape. Discharging of mining wastes in the rivers and creation of spoil heaps also have negative impacts on the ecological habitats, and hence on the biodiversity levels they harbour. Local authorities and the national government, motivated by the directives of the European Union (EU) to which Poland has recently joined, aim to find a balance between flood risk reduction and biodiversity conservation. The EU is committed to conserving the ecological status and especially the biodiversity riches in the wetlands under Article 1(a) of the EU Water Framework Directive (WFD 2000/60/EC). Wetland conservation is also provided for under the EU Birds Directive (1979/409/EC) and the EU Habitats Directive (1992/43/EC).

This chapter aims to assist Polish policymakers in making optimal biodiversity conservation and flood risk reduction policy, by using a choice experiment to quantify the tradeoffs between flood risk reduction, biodiversity conservation and improvements in access to the wetland for recreational purposes. The study explicitly accounts for preference heterogeneity by analyzing choices using a covariance heterogeneity model. Stated preferences over constructed alternatives, data on environmental attitudes, household-level social, economic and demographic characteristics, as well as data on households' past recreational activities in the wetland and flood damages suffered in the past, are collected from 192 households located in the wetland area. Our main findings reveal that households derive the highest benefits from a reduction in flood risks to a 'low' level. In terms of the value of changes in attributes, flood risk reduction is followed by improvements in access to the wetland for recreational purposes and, finally, by conservation of high levels of biodiversity. These results have important repercussions for the design of efficient, effective and equitable wetland management projects and policies.

The following section presents the theoretical underpinnings of the choice experiment (CE) method and the econometric models estimated. Section 3 describes the case study and Section 4 explains the survey design and administration. The results of the econometric estimation are reported in Section 5, and Section 7 concludes the chapter implications for wetland management policy in the region.

2. The choice experiment method

To illustrate the basic model behind the CE presented here, consider a local resident's choice of wetland management plans. Assume that utility depends on choices made from a choice set C, which includes all possible wetland management plan profiles. The respondent has a utility function of the form:

$$U_{ij} = V(Z_{ij}) + e(Z_{ij}) \tag{1}$$

For any respondent *i*, a given level of utility will be associated with any wetland management plan alternative *j*. Utility derived from any of the wetland management plan alternatives depends on the attributes of the plan (expressed in vector *Z*), such as the flood risk level, level of biodiversity conserved and level of accessibility of the river for recreational purposes.

Random utility theory (RUT) is the basis for integrating behaviour with economic valuation in the CE method. According to RUT, the utility of a choice comprises a deterministic component (*V*) and an error component (*e*), 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 between alternatives will be a function of the probability that the utility associated with a particular wetland management plan option *j* is higher than with other alternatives.

Assuming that the relationship between utility and attributes is linear in the parameters and variables function, and that the error terms are identically and independently distributed with a Weibull distribution, the probability of any particular wetland management alternative *j* being chosen can be expressed in terms of a logistic distribution. Equation (1) can be estimated with a conditional logit model (CLM) (McFadden 1974; Greene 1997, pp. 913–914), which takes the general form:

$$P_{ij} = \frac{\exp(\beta' Z_{ij})}{\sum_{h=1}^{C} \exp(\beta' Z_{ih})} \tag{2}$$

where the conditional indirect utility function generally estimated is:

$$V_{ij} = \beta + \beta_1 Z_1 + \beta_2 Z_2 + \cdots + \beta_n Z_n \tag{3}$$

where β is the alternative specific constant (ASC) which captures the effects on utility of any attributes not included in choice-specific wetland management plan alternative attributes, *n* is the number of wetland management plan alternative attributes considered, and the vectors of coefficients β_1–β_n are attached to the vector of attributes (Z).

The CLM has been the primary model for analysing stated preference data from choice experiments. However, it has been recognised to have a major shortcoming: namely, it imposes homogeneous preferences for all respondents (unless these can be adequately represented using interactions with observable socioeconomic characteristics) and, furthermore, does not allow for error correlation across respondents' choices. To take into account possible preference heterogeneity among respondents, a number of alternative models to the standard CLM have been proposed. In this chapter we employ the covariance heterogeneity (Cov Het) model to represent underlying preference heterogeneity within responses to the choice questions.

The Cov Het model (Bhat 1997) includes heterogeneity in terms of the error component of utility *e*. It involves estimating a model in which the error variance is a function of choice attributes, as well as respondent-level socioeconomic, attitudinal and behavioural characteristics. The Cov Het model used in this chapter follows Colombo and Hanley (2007) and is approached as a generalisation of the nested logit model where the inclusive value utility parameter is specified to be an exponential function of the covariates (Louviere *et al.* 2000):

$$\sigma_j = \tau_j \exp(\gamma Z_j) \tag{4}$$

where τ_j is the inclusive value parameter, Z is a vector of the choice experiment attributes, as before, as well as respondent-level socioeconomic, attitudinal and behavioural characteristics, and γ is a vector of parameters to be estimated. Assuming that the unobserved utility is type 1 extreme value distributed, the probability that alternative *k* will be selected given the branch choice *j* is given by:

$$P(k \mid j) = \frac{\exp(\beta' X_{k|j})}{\sum_{s|j} \exp(\beta' X_{s|j})} \tag{5}$$

where β is the vector of utility coefficients to be estimated, $X_{k|j}$ are the variables that vary within nests and *s* is the number of alternatives in branch *j*.

The probability that branch *j*is chosen is given by:

$$P(j) = \frac{\exp(a' Y_j + \sigma_j IV_j)}{\sum_j \exp(a' Y_j + \sigma_j IV_j)} \tag{6}$$

where, α, σ are parameters to be estimated and *Y* are the variables that vary across nests.

3. The case study

The choice experiment study reported in this paper was implemented in the city of Sosnowiec, located in the Bobrek catchment, in the Upper Silesia Region of Poland. The region is an important industrial center located within the Upper Silesian Coal Basin. Five rivers run through the wider area. These are Biala, Brynica, Jaworznik, Wielonka and Rawa rivers. This abundance of rivers renders the region susceptible to flooding episodes (Figures 3.1 and 3.2).

Figure 3.1 Location of the study site in Poland.

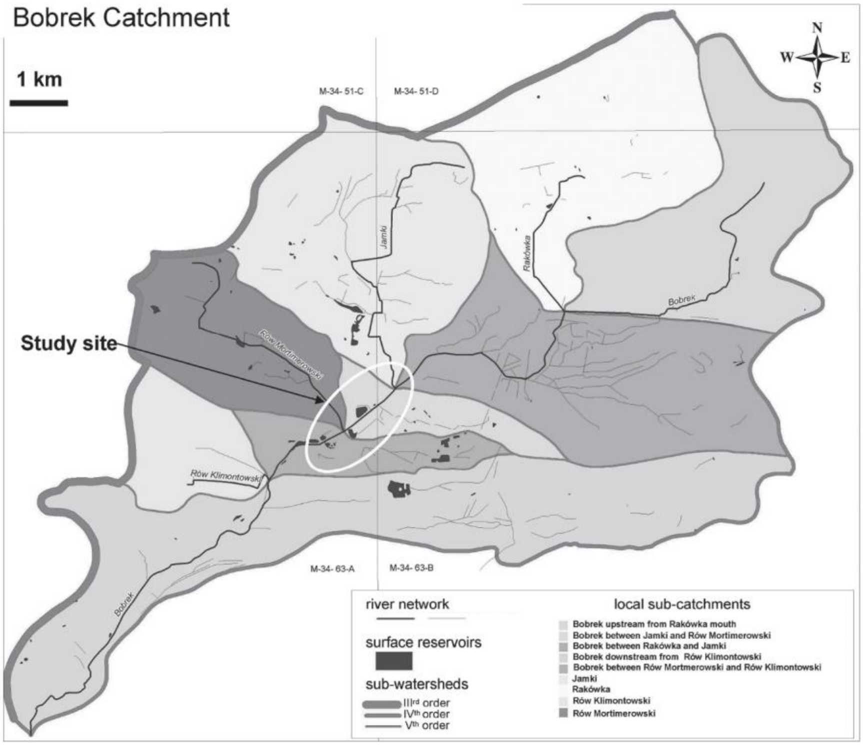

Figure 3.2 Map of the Bobrek catchment. *Source*: Map of hydrographic division of Poland, Institute of Meteorology and Water Management (ImiGW), http://www.imgw.pl/wl/internet/zz/zz_xpages/hydrografia/zasoby_wodne.html.

For over two centuries the main economic activity in the area has been mining. In fact some of the world's largest bituminous coalmines are located in the region. The mines are located close to the region's rivers, and thus have ongoing impacts on the rivers' morphology. Scientific evidence from Central Mining Institute, Silesian University, AGH University of Science and Technology, and Krakow University of Technology shows that the mining industry has significantly deformed the local landscape and the riverbeds, thereby rendering the region extremely vulnerable to floods even after light rainfall episodes. Given the size of the local communities, it is estimated that approximately 50,000 individuals are currently at risk from flooding.

In 1992 the Polish government facilitated the construction of concrete barriers on the riverbanks in order to minimize the risk of flooding. Mining industries were deemed responsible for protecting their mines by constructing spoil heaps on the riverbanks. This plan, however, was not successful since it increased the speed of water flow, thereby generating negative externalities for downstream communities. Moreover, recreational activities in the catchment became limited as a result of the blocking of the river access by concrete barriers. Furthermore, this policy was not successful in providing flood control as the extensive floods of 1997 and 2001 can attest.

The high economic and social costs of flooding episodes are borne mainly by the local residents, but also by the overall national economy and the nearby countries. Despite these costs, floods have also brought about benefits in the form of unique ecological wetland habitats which flourished on those lands that have been flooded by the rivers. New species of flora and fauna have colonised these habitats. Ecologists from Silesian University recognise these biodiversity riches and assert that they should be conserved. In addition, these habitats are now of high recreational value, with the potential to serve as an attractive tourism and recreational destination. The ecological health of these habitats is, however, currently under threat from pollution caused by the spoil heaps created by the mining industry.

4. Survey design and administration

A CE crucially relies on the definition of the good to be valued in terms of its attributes and levels. The attributes selected should be those that the public considers important regarding the proposed policy or management plan change, whereas attribute levels should be achievable with and without a proposed policy or management plan change (Bateman *et al*. 2003). The good valued in this choice experiment study is a ‘wetland management plan’. Following discussions with scientists from the Central Mining Institute, the Silesian University, the AGH University of Science and Technology and the Krakow University of Technology, and drawing on the results of focus group discussions with members of the local population, a simple CE was envisaged and three wetland management plan attributes were chosen. These were surface and underground flooding risks; biodiversity found in the wetland; and access to the river bank for recreational purposes. All three of these attributes were specified to have one of two levels.

The *flood risk* attribute refers to the predicted risk of flooding in the area in the next 10 years. At present, the risk of flooding is high. However, if both underground and surface barriers are improved, risks of flooding can be reduced. The *river access* attribute refers to the public’s access to the riverbank for recreational purposes (e.g. walking, cycling and fishing). At the moment access to the riverbank is difficult, following the building of concrete vertical walls a few years earlier as an (unsuccessful) flood risk reduction measure. If, however, these concrete walls are demolished and the river is recanalised similarly to its natural state, it could easily be accessed for recreational purposes. Finally, the *biodiversity* attribute refers to the number of different species of flora and fauna, their population levels, number of different habitats and their size in the wetland ecosystem in the next 10 years. Even though, as a result of flooding, biodiversity levels have increased to higher levels than before, present regulations do not prohibit mining companies from creating spoil heaps or discharging mine drainage water into the river. Both of these practices pose considerable threats to the wetland habitats, and they are expected to decrease the biodiversity levels to a low level within the next 10 years. If, however, mining companies are prohibited from creating spoil heaps and if reclamation activities, such as afforestation take place, biodiversity levels can reach a higher level in the next 10 years.

The payment vehicle used was a percentage change in the local taxes paid by the households in the next 10 years. A percentage change in the household's present tax level was preferred over fixed changes in the tax levels, since the former allows for a continuous monetary variable. Furthermore, allowing for higher and lower tax levels compared to the status quo level enables understanding of whether the households are willing to pay to have higher/lower levels of these attributes or willing to accept compensation to let go higher/lower levels of these. Following the choice sets, information was collected on the monthly local taxes paid by each household and, using this figure, taxation levels used in the CE (i.e. −10%, −5%, 5% and 10%) were converted to monetary (zloty) amounts that were different for each household. This generated an almost continuous monetary variable out of the four percentage levels used in the experimental design. Finally, taxation was preferred as a payment vehicle over voluntary donations since households may have the incentives to free-ride with the latter (Whitehead 2006). Table 3.1 summarizes the definition of the attributes and their levels.

A large number of unique wetland management plans can be constructed using these attributes and their levels. Using experimental design techniques (Louviere *et al.* 2000) an orthogonalisation procedure was used. This procedure resulted in 32 pair-wise comparisons of wetland management plans. These were randomly blocked into four versions, each containing eight choice sets consisting of two wetland management plans and an opt-out alternative, which represented the status

Table 3.1 Selected wetland management plan attributes, their definitions and levels

Attribute	*Definition*	*Levels*
Flood risk	Risk of flooding in the area in the next 10 years	Low**, *High**
Riverbank access	Public's access to the riverbank for recreational purposes in the next 10 years	Easy, *Difficult*
Biodiversity	Number of different species of plants and animals, their population levels, number of different habitats and their size in the wetland ecosystem in the next 10 years	*Low*, High
Local tax	Percentage change in the monthly local tax paid by every household in the area in the next 10 years	−10%***, −5%, *0*, +5% +10%

* Status quo attribute levels are underlined; ** with the effects coding low flood risk, easy riverbank access and high biodiversity levels were coded as 1 and high flood risk, difficult riverbank access and low biodiversity levels were coded as −1; *** these percentages were translated into zlotys using the monthly local tax figures reported by each household.

Table 3.2 Example choice set: assuming that the following three wetland management plans were the only choices you had, which one would you prefer?

Management plan characteristics	*Management plan A*	*Management plan B*	*Neither management plan: status quo*
Flood risk	Low	Low	High
Biodiversity	Low	High	Low
River access	Difficult	Easy	Difficult
Monthly local tax	5% decrease	5% decrease	Same as now
I prefer (please tick as appropriate)	Management plan A	Management plan B	Neither management plan

quo Table 3.2, in which case no management actions would be undertaken and tax rates would not change. Inclusion of the status quo or another baseline scenario is important for the welfare interpretation of choice experiment estimates and for their consistency with demand theory (Louviere *et al.* 2000; Bennett and Blamey 2001; Bateman *et al.* 2003).

The CE survey was implemented in March and April 2007 in the city of Sosnowiec, using in-house, face-to-face interviews. Time and budget constraints allowed for a sample of 200 households from the local population. A quota sample was collected and the survey was administered to be representative of the local population in terms of income and geographical distribution (i.e. distance from the river). Those household members who took part in the survey were by and large those who were the main household decision makers and/or heads of the households. In total, 96 % of those approached, i.e. 192 households, agreed to be interviewed.

The CE survey started with the enumerators reading a statement identifying the current issues in the area regarding flood risks, biodiversity conservation and use of the riverbank for recreational activities. Subsequently, the households were presented with a description of the attributes used in the CE and they were asked to state their preferred wetland management plan among three such plans in eight choice sets. Overall, a total of 1536 choices were elicited from 192 households.

Data were also collected on the households' social, demographic and economic characteristics, as well as information on whether the household uses the riverbank for recreational activities, and on whether the households were affected by the flooding episodes of the past decade. Descriptive statistics for the key variables are presented in Table 3.3.

The sampled households' average monthly income, average monthly local tax paid and demographic composition, as well as the age and education levels of the respondents, are representative of the population of Sosnowiec. Even though, on average, households are located almost half a kilometre (462 metres) away from the river, almost 13 % have been flooded an average of 2.5 times in the past decade. The total average damages suffered by flooded households in the past 10 years is 7115.8 zloty (E,1871), and for some as high as 25,000 zloty (E6574).

Table 3.3 Descriptive statistics of respondents and their households (sample size = 192)

Household and respondent-level characteristics	*Mean (S.D.)*
Average age of the respondents (in years)	45.6 (16.2)
Average household size	2.8 (1.1)
Average monthly gross household income (in zloty)	2478.1 (1253)
Average monthly household local tax (in zloty)	183.9 (11.8)
Households' average distance from the river (in metres)	462 (249.8)
Average number of flood episodes suffered in the last decade	2.52 (2.99)
Average of total damages from floods in the last decade (in zloty)	7115.8 (6611)

Household and respondent-level characteristics	*Percentage*
Respondents with a university degree and above	26
Households with at least one child	70.8
Households who use the riverbank for recreational purposes	54.6
Households who would like to use the riverbank in the future for recreational purposes	66.7
Households flooded	13
Flooded households compensated	28

Source: Upper Silesia River Management Choice Experiment, 2007.

Less than a third of these flooded households have been compensated, the majority of whom (49 %) by the mining industry, some (28 %) by the government and a minority (13 %) by an insurance company. Over a half of the sample are regular visitors of the riverbanks and rivers. They stated that they engage in a wide array of recreational activities, ranging from walking and sailing to appreciating its aesthetic beauty and bird watching, as well as for educational purposes; 66.7 % of the respondents stated that they would like to visit the wetland in the future to engage in recreational activities.

In addition to these social, economic, demographic, flood-related and present and future recreational wetland use data, several attitudinal and behavioural questions were asked in order to understand respondents' behaviour and consciousness with regards to environmental issues. Households' actual environmental behaviour was assessed via questions eliciting their purchase of organic produce, environmental publications and fair-trade products; their donations to environmental organisations and shopping at environmentally friendly shops. These were measured on a five-point Likert scale, ranging from 'never' to 'always', and an environmental behaviour index (EBI), ranging from 5 to 20, was calculated. The level of the respondents' environmental consciousness was measured through questions eliciting how concerned they were with regards to several environmental issues, such as the scarcity of environmental resources, ecological crisis, human interference with the environment and the current situation of wetlands in Poland. Similarly, to EBI, and environmental consciousness index (ECI) was calculated by using a Likert scale, which ranged from 5 to 30. The sample averages for ECI and EBI are also reported in Table 3.4.

Table 3.4 Cov Het Model estimates for wetland management plan attributes

Attributes in utility function: wetland management plan attributes	*Coefficient (S.E.)*
ASC	0.001 (0.183)
Flood risk	0.304*** (0.038)
Biodiversity	0.081***(0.0304)
Riverbank access	0.125*** (0.034)
Local tax	−0.026*** (0.002)
Attributes of branch choice equation: household and respondent characteristics	
ASC	− 0.901 (1.501)
Recreationalist	0.654*** (0.162)
Income	0.0001 (0.0001)
ECI	0.080* (0.044)
EBI	− 0.096* (0.056)
University degree	0.958** (0.423)
Covariates in inclusive value parameters	
Flood risk	− 0.156** (0.070)
Biodiversity	− 0.101 (0.062)
Riverbank access	− 0.268*** (0.092)
Local tax	− 0.009** (0.004)
ECI	− 0.036* (0.019)
EBI	0.015 (0.031)
Recreationalist	− 0.678*** (0.251)
Distance from water	− 0.0008*** (0.0003)
University degree	− 0.166 (0.310)
Future visit	0.384** (0.151)
Log likelihood	− 1399.757
ρ^2	0.208
Observations	1536

Source: Upper Silesia River Management Choice Experiment, 2007.
Two-tailed tests showed 10% (*), 5% (**) and 1% (***) significance levels.
ASC, alternative specific constant; EBI, environmental behaviour index; ECI, environmental consciousness index.

5. Results

5.1. Covariance heterogeneity model

The results of the covariance heterogeneity (Cov Het) model are presented in Table 3.4.

The first set of estimates reports the coefficients of the attributes in the utility function. All attributes are statistically significant determinants of wetland management plan choice. Respondents are more likely to choose a wetland management plan that reduces flood risk to a lower level, generates a higher level of biodiversity and facilitates easier access to the riverbank for recreational purposes. As expected a priori, respondents are less likely to choose those wetland management plans with higher costs, i.e. with higher local tax. The most important determinant of choice is the flood risk attribute, followed by riverbank access and biodiversity level.

The second set of estimated parameters reports the results of the branch choice equation logit model, where the behavioural model assumes that respondents decide between selecting one of the alternative scenarios presented (wetland management plan A vs B) or remaining in the status quo (neither management plan). A positive estimated coefficient implies that the respondent is more likely to choose one of the two alternative wetland management plans compared to the status quo. The coefficients for the respondent- and household-specific variables included in the Cov Het model are all significant, with the exception of the income variable. Having visited the wetland for recreational purposes, having been flooded in the past, and having a university degree all increase the probability that the respondent will select one of the wetland management scenarios (A or B) rather than the status quo of doing nothing. This is also the implication of higher income; however, this effect is not statistically significant. The ECI has a significant and positive effect on branch choice. The effect of the EBI is interesting in that individuals with a higher EBI are more likely to select the status quo option.

The estimated coefficients of the variables in the inclusive value parameters indicate that the random component of utility is affected both by wetland management attributes and respondents' socioeconomic, attitudinal and behavioural characteristics. Conditional on the respondents selecting one of the two options diverging from the status quo, the error variances are systematically related to the design attributes and socioeconomic variables. Specifically, the negative and significant coefficient of the 'recreationalist' variable indicates that recreationalists have a lower scale parameter and, as a result, a higher variance of the random component of utility. The same effect is observed for individuals with higher ECI and those that live further from the water. The opposite effect is present for those that may visit the wetland in the future for recreational purposes. Regarding the design attributes, all but biodiversity significantly affect random component variance. Lower flood risk, improved riverbank access and higher tax rates increase random component variance.

5.2. Welfare estimates for wetland management plan attributes

The CE method is consistent with utility maximisation and demand theory (Bateman *et al.* 2003). The compensating surplus (CS) welfare measure for changes in the wetland management plan attributes can be derived from the estimated parameters by using the following formula (Hanemann 1984; Bateman *et al.* 2003):

$$\mathrm{CS} = -\frac{\ln \sum_i \exp(V_{i1}) - \ln \sum_i \exp(V_{i0})}{\beta_{\mathrm{localtax}}} \qquad (7)$$

where, $\beta_{\mathrm{localtax}}$, the coefficient on the monetary attribute, gives the marginal utility of income and V_{i0} and V_{i1} represent indirect utility functions before and after the policy change under consideration.

Table 3.5 Marginal willingness to pay (MWTP) (implicit prices) and 95% confidence intervals (in parentheses) for river management attributes (all figures are in zloty per household per month)

Attribute	*MWTP*
Flood risk	23.4 (19–28.5)
Biodiversity	6.2 (3.61–9.3)
Riverbank access	9.6 (6.5–13.3)

Source: Upper Silesia River Management Choice Experiment, 2007. Welfare measures are calculated with the Delta method of the Wald procedure contained within LIMDEP 8.0 NLOGIT 3.0.

The marginal value of change in a single wetland management plan attribute can be estimated as a ratio of coefficients. The ratio represents the marginal rate of substitution between local tax and the wetland management plan attribute in question, or the marginal welfare measure—(willingness to pay (WTP))—for a change in any of the attributes:

$$\text{WTP} \qquad \frac{2x\beta_{\text{attribute}}}{\beta_{\text{localtax}}} \tag{8}$$

where $\beta_{\text{attribute}}$ is the coefficient on the river management attributes (level of flood risk, biodiversity and river access). This coefficient on the wetland management plan attributes are multiplied by two since their binary levels were effects coded (Hu *et al*. 2004).

Table 3.5 reports the implicit prices, or marginal WTP (MWTP) values, for each of the wetland management plan attributes estimated using the Wald procedure (Delta method) in LIMDEP 8.0 NLOGIT 3.0. According to the MWTP values reported in Table 3.5, households would be WTP 23 zloty per month for those management plans that would minimise the flooding risk to a low level, half of this amount for improving recreational benefits generated by the wetland, and a fourth of this amount for conservation of the biodiversity at high levels.

The implicit prices reported in Table 3.5 do not provide estimates of CS for the alternative management scenarios. To estimate the households' CS for improvements in river management over the status quo, three possible management scenarios are created:

- Scenario 0—status quo; this is the baseline situation where the flood risk level is high, biodiversity level is low and the access to the river for recreational purposes is difficult.
- Scenario 1—in this scenario flood risk is reduced to a low level and the access to the riverbank for recreational purposes is improved.
- Scenario 2—in this scenario conservation actions are undertaken to generate a high level of biodiversity, whereas access to the riverbank for recreational purposes is improved.

Table 3.6 Compensating surplus and 95% confidence intervals (in parentheses) for three river management scenarios (all figures are in zloty per household per month)

Scenario	*MWTP*
Scenario 1	33(25.5–41.8)
Scenario 2	15.9 (10.1–22.5)
Scenario 3	39.2 (29.1–51)

Source: Upper Silesia River Management Choice Experiment, 2007.

- Scenario 3—in this scenario flood risk is reduced to a low level, conservation actions are undertaken to generate a high level of biodiversity and the access to the riverbank for recreational purposes is improved.

CS estimates for these scenarios are reported in Table 3.6. These estimates reveal local households' average WTP in terms of higher local taxes to move from the status quo (Scenario 0) to Scenarios 1, 2 and 3. CS increases in the intensity of the management scenario, and households would be WTP as much as 39 zloty per month for scenario 3.

6. Conclusions and policy implications

This chapter reports the results of a choice experiment study undertaken in the Bobrek wetland, located in the Upper Silesia region of Poland. The aim of this study was to investigate the local public's preferences for alternative wetland management scenarios, defined by their impacts on flood risk, biodiversity conservation and riverbank access for recreational purposes. The data are analysed by using a covariance heterogeneity (Cov Het) model in order to capture heterogeneity in the random component of the local public's preferences.

The results reveal that the local public derives the highest values (i.e. economic benefits) from flood risk reduction. This result is not surprising considering that the catchment area is susceptible to flooding episodes, as extensive floods of 1997 and 2001 and the social and economic damages these have caused can attest.

Compensating surplus (CS) measures for different wetland management scenarios are also calculated. The results reveal that according to the weighted average of the better-fitting LCM, the local public are WTP the most for a wetland management. The estimated CS for the wetland management scenario that reduces flooding risk, generates higher levels of biodiversity conservation as well as facilitating easy access to the riverbank for recreational purposes is as much as 39 zloty per household per month, which is 21 % of the current monthly local taxes paid by an average household in the area.

The estimated benefits of these scenarios should be compared to their costs, in order to investigate whether or not undertaking such plans would improve welfare in this region of Poland. With the use of the benefits transfer method, this study could also provide policy-makers with useful information for management of other similar wetlands in Poland, as well as in Europe, given the current mandate under the EU's Water Framework Directive, since this directive requires regulators to compare benefits and costs in terms of whether waters should be designated as 'heavily modified', and thus qualify for lower environmental targets than Good Ecological Status.

Acknowledgements

We gratefully acknowledge the European Union's financial support through the AquaStress project under the 6th Framework Programme. We would like to thank Elzbieta Druzynska and Andrzej Potocki for valuable comments, suggestions and fruitful discussions. We would also like to thank Haris Gianniakidis and Nickolaos Syrigos for their assistance in data collection.

References

Bateman, I.J., Carson, R.T., Day, B., *et al*. 2003. *Guidelines for the Use of Stated Preference Techniques for the Valuation of Preferences for Non-market Goods*. Cheltenham: Edward Elgar.

Bennett, J.J., Blamey, R.K. 2001. *The Choice of Modelling Approach to Environmental Valuation*. Cheltenham: Edward Elgar.

Bhat, C.R. 1997. Covariance heterogeneity in nasted logic models: econometric structure and application to intercity…. *Transportation Research* Part B.

Brakenridge, G.R., Anderson, E., Caquard, S. 1997. Flood Archive table 1997. Dartmouth Flood Observatory, Hanover, USA, digital media, http://www.dartmouth.edu/~floods/Archives/1997sum.htm

Brakenridge, G.R., Anderson, E., Caquard, S. 2001. Flood Archive table 2001, Dartmouth Flood Observatory, Hanover, USA, digital media, http://www.dartmouth.edu/~floods/Archives/2001sum.htm

Colombo, S., Hanley, N. 2007. Modelling preference heterogeneity in stated choice data for environmental goods. Discussion papers in Economics, University of Stirling. www.economics.stir.ac.uk.

Greene, W.H 1997. *Econometric Analysis*, 3rd edn. New Jersey: Prentice-Hall.

Hanemann, W.M. 1984. Welfare evaluations in contingent valuation experiments with discrete responses. *American Journal of Agricultural Economics* 71(4): 1057–1061.

Hu, W., Hünnemeyer, A., Veeman, M., Adamowicz, W.L., Srivastava, L. 2004. Trading off health, environmental and genetic modification attributes in food. *European Review of Agricultural Economics* 31: 389–408.

Louviere, J.J., Hensher, D., Swait, J., Adamowicz, W. 2000. *Stated Choice Methods: Analysis and Applications*. Cambridge: Cambridge University Press.

McFadden, D. 1974. Conditional logit analysis of qualitative choice behaviour. In: P. Zarembka (ed.) .*Frontiers in Econometrics*. New York: Academic press, pp. 105–142.

Nicholls, R.J., Hoozemans, F., Marchand, M. 1999. Increasing flood risks and wetland losses due to global sea-level rise: regional and global analyses. *Global Environmental Change,* 9: S69–S87.
Pearce, D., Moran, D. 1994. *The Economic Value of Biodiversity*. London: Earthscan.
Whitehead, J.C. 2006. A practitioner's primer on contingent valuation. In: A. Alberini and J. Kahn (eds), *Contingent Valuation Handbook*. Cheltenham: Edward Elgar.