# THE POSSIBILITY OF THE ECONOMIC EVALUATION OF ECOSYSTEM SERVICES DESCRIBED THROUGH A DOMESTIC CASE STUDY


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## 1. Introduction

The evaluation of ecosystem services is a highly relevant issue worldwide; this concept is useful for the development of economic evaluation methodology. Such evaluations can provide significant assistance to European Union Member States in carrying out their obligations; for example, performing an economic analysis on the benefits or costs of the Water Framework Directive. However, this type of economic evaluation can be problematic. There is criticism of the methodology; for instance there are few practical examples, or there is the risk of double counting (e.g. counting the same ecosystem services several times), etc. Despite all of these problems, great efforts have been made to improve the methodology of economic evaluation throughout Europe. This paper presents findings from a piece of national research as part of international research effort. Aims of the research related to the above-mentioned WFD requirements were to determine specific evaluation methodology and develop environmental policy proposals. The novelty of the research is that it was the first time that so-called 'choice experiment' methodology had been used in Hungary. This method has many advantages and is widely accepted.

This evaluation technique was used in contrast to (or rather, in addition to) the contingent valuation method, resulting in added value, because this research relied on both methods and findings. Sixteen international research institutions from ten countries took part and formed three focused working groups: water scarcity, water quality and ecosystem restoration. A Hungarian research team (together with teams from Austria and Romania) belonged to the latter. The main goal was to investigate the estimated benefits of ecological restoration in the Danube floodplain in terms of welfare impacts. More specifically, the study attempted to estimate the non-market benefits of ecological restoration of the heavily modified international Danube river bed in three different countries. Common methodological and research principles were used. The results, which are now presented, include only the domestic results, but the overall aim of this research was international comparison of these results and testing the so-called 'benefits transfer'.

## 2. Methodology

### 2.1. Contingent valuation

Contingent valuation is one of the oldest and most commonly used stated-preference methods; through use of a survey that shows a direct way to express changes in related individual preferences, which occur with non-market goods. Ciriacy-Wantrup laid down its foundations around the middle of the 20th century, but in recent decades, it has been used in empirical research in thousands of occasions. This has resulted in a well-identified theoretical procedure (a number of exhaustive works have helped to define the method; see, for example, Mitchell and Carson 1989; in Hungarian Marjainé Szerényi 2005). During the research a hypothetical market is created in which the evaluated good is described. In addition, a hypothetical program can be presented, in which people's contributions are asked for, and the method of payment is defined and willingness-to-pay (WTP) is examined. Good in question is "traded" in the hypothetical market through a survey of respondents. This method reveals how much respondents are willing to offer (a maximum amount) for the presented hypothetical change. If respondent's willingness to pay (WTP) changes according to the welfare of members of society, a result of intervention can be estimated (through the aggregation of individual WTPs, in which all affected must be considered). The description of the hypothetical changes in the program must be as realistic and believable as possible. Attention must be paid to any aspects, which are already important during any public inquiry (i.e. ensuring the survey text is understandable and contains only proper amount of information, etc.).

Through the contingent valuation any benefits/damages can be estimated in connection to the whole change expected. The great advantage of this methodology is that it evaluates practically any stock and change. Moreover, defines the use and non-use components of the so-called total economic value, which has great importance regarding ecosystems. In many cases habitat is valuable, but not because people use it directly. In Hungary, the Contingent Valuation method has been used a few times, for example to evaluate the benefits of improved water quality in the Lake Balaton *(Mourato et al. 1997)*, and the conservation of the Pál Valley- and Szemlő Mountain caves *(Marjainé Szerényi 2000).*

### 2.2. The choice experiment

The choice experiment (CE) has much less history in the evaluation of non-market goods. It was first used to examine the impacts of environmental goods in the mid 1990's *(Adamowitz 1995).* Since then, the number of studies that estimated the welfare effects of changes with this procedure has rapidly grown *(Bateman et al. 2002; Krajnyik 2008 - gives a good summary about the method in Hungarian)*. Similar to contingent valuation, it can be classified as a stated-preference method, since it also creates a hypothetical market. But "trading" with the goods is done differently. The environmental goods being valued are examined through their features/characteristics at different levels. Different bundles/packages can be created from features defined at different levels, and respondents evaluate the goods and their features through the selection of these packages. One of the features is always a price component; a cost would be paid (hypothetically) to achieve the outcomes. The individual's maximum willingness to pay is not asked directly, but it is found out through indirect analysis of the chosen program package.

A good evaluation should put strong emphasis on two aspects: the attributes themselves and their levels. It is important that only the most important attributes are included in the study *(Hensher 2004)*, and that they must be independent. Too many attributes should not be involved in the study to avoid over-complicating the program packages and make the choice difficult. A similar principle prevails in determining the levels of attributes; an effort has to be made to determine transparent numbers of levels. As was mentioned earlier, features should contain one that represents price. It can be expressed as a cost factor, although it can also not have monetary value, for example travel distance, which can be expressed in monetary terms during the analysis. The program packages are formed from the combination of attributes determined at various levels. In the examination, it is important that any choice includes the possibility that respondents can be satisfied with current situation and have zero willingness to pay (so the interviewed can choose essentially between three options in case each of the choices: A, B and status quo). Interviewees express their preferences generally in more choice situations, so sample size is significantly reduced. Due to the complexity of evaluation issues, using personal interviews during surveying is best. Apart from electoral cards other tools can be used for improving information transfer.

Compared to contingent valuation, the biggest advantage of this methodology is that it assigns economic value not only to one specific program, but to all of the included attributes, making it easier to determine what kind of tradeoffs respondents make between individual attributes and their levels (i.e. how much a given level of some attribute is worth to them compared to other levels and other attributes). Like the previous procedure, this method shows the great potential for ecosystem assessment because it is suitable for estimating non-use value components. The disadvantage is that - depending on the complexity of the developed program packages – it can be very stressful/ difficult for respondents to choose that package which contains their preferences. As more features and levels are used, respondents are less and less able to thoroughly review and decide using the choice situation.

## 3. Domestic case study presentation

### 3.1. The study area and the problem

The Danube is the second largest river in Europe. In the last century it has been exposed to various anthropogenic changes and environmental pressures. Among other things, the shape of the river has changed and most of the floodplains have been drained for agricultural purposes. The hydrological connection/permeability of the river has significantly decreased along with its side branches and connections to the surrounding floodplains *(see, e.g. Hohensinner et al. 2004, Brouwer et al. 2009)*. To ensure meeting the Water Framework Directive requirements and reach good ecological status, one possibility is to restore the river sections as closely as possible to the natural hydro-morphological state *(Brouwer et al. 2009).*

The Által-streamlet is located in north-western Hungary. Its basin surface area is 521 km2; the length of the stream arising from the Vértes Mountains is 50 km. In total, it has 31 tributaries; the two main ones are the Galla creek – which flows through Tatabánya – and the Kecskéd creek – which touches Oroszlány. The largest lake is the Old Lake (230 ha) of Tata. Only the two sections of the Által-streamlet can be classed as "natural bodies of water", according to the 2nd National Report concerning to the 5th article of the WFD (EU code: HU_RW_AAA206_0000036_S and HU_RW_AAA206_0000045_M; http://www.euvki.hu/content/2005jelentes.html). There are three bigger settlements in the catchment area, Tatabánya, Oroszlány and Tata. Earlier these were important industrial cities. Despite the fact that there are many rivers in the catchment area, only a few have significant and permanent water yield. For this reason, during the summer there is often lack of water but in the case of heavy rain, floods pose threat. This is mainly due to human intervention (together there are 19 man-made lakes in the area, land use has changed and agricultural land use now prevails).

Only a small quantity of water is used for irrigation while significant amounts of the Által-streamlet is used for ensuring the cooling water needs of industrial companies. A large part of the Által-streamlet's water body is heavily modified. In the area, the drinking water supply is provided by karst water *(AquaMoney Project, 2008)*.

### 3.2. Survey Specifics

The survey was carried out amongst residents of the pre-selected settlements of the Által-streamlet catchment area through personal interviews between November 2008 and January 2009. Attempts were made to include respondents in the sample who lived also in the upper, middle and lower parts of the catchment. The largest number of respondents was from Tata, Tatabánya and Oroszlány. Altogether 892 people were approached, of whom 471 completed the survey (a response rate of 52.8%).

In the survey, questions were formulated about the respondent's environmental attitudes, the use of the study area, water use habits, water bill, opinions about water quality, previous flood experience and numerous socio-economic features (age, income, education, type of home). The evaluation questions were compiled in two separate sections in the case of contingent valuation and choice experiment.

During the contingent valuation survey, a program was offered to "buy" (i.e. the contribution was asked for this purpose) an increase in the proportion of near-natural areas from the current 25% to 50%, or 90% on the hypothetical market. This program implementing the changes involved works to connect better wetland habitats and forests. The maps illustrate the difference between the situations (see Figure 1). The sample was divided into two parts. One group was offered the program, which described an increase to 50% of near-natural areas, while the other group was offered a program, which described an increase to 90% (i.e. the two improvement situations were evaluated totally independently from each other). The exact question was: "Using the next card can you tell me please how much your household would be willing to pay per year, maximum, above your annual water bill over the next 5 years to make this recovery happen?" The respondent could choose the amount of their contribution using a so-called payment card. On this card thirty different amounts were presented, which included 0 Ft and another category in which any amount of money could have been named.

In the choice experiment two additional features were selected for evaluation: frequency of flooding and water quality. The levels of flood frequency used the following options: flooding once every five years, once every 25 years, once every 50 years and once every 100 years. In case of water quality the options were: medium, good and very good levels. The additional cost of the water bill was set at four amounts: 50/200/650/1000 Ft per month. Pictograms were used to illustrate the water quality change and the resulting use opportunities (for levels of the features and pictograms, see Figure 2).

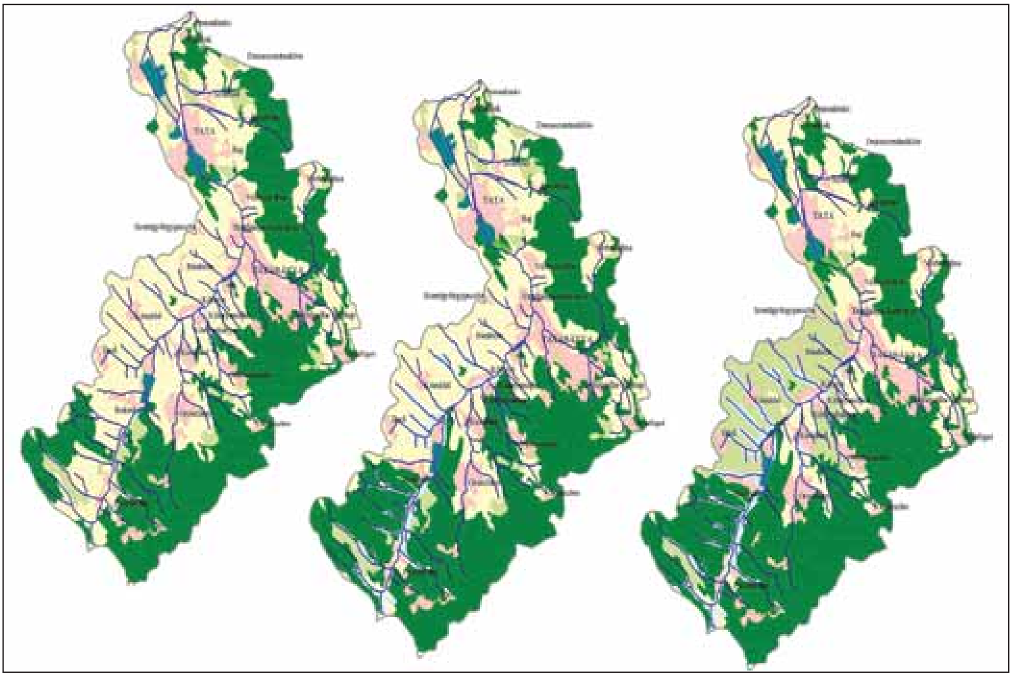

*Figure 1*: Maps used to illustrate scenarios of ecological rehabilitation: from left to right the current situation, 50% of the area, and 90% of the area in near-natural condition (these scenarios/maps were drawn up by Research Istitute for Soil Science and Agricultural Chemistry of the Hungarian Academy of Sciences).

A total of thirty-two choice situations were developed from each level of the three features (meaningless evaluation situations were corrected). Before that, it was explained that the program could improve water quality and flood situation. To ensure that the welfare effects (social benefits) could be correctly quantified, it was necessary to correlate them to the current situation, which was represented as a third choice situation next to the two alternatives (labelled "current situation"). In this alternative the flood frequency was once every three years, while the water quality is at a medium level (you can see one example of the choice situation in Figure 3) (the baseline scenario was also derived through expert input from Research Istitute for Soil Science and Agricultural Chemistry of the Hungarian Academy of Sciences). Of course, those who chose the current situation were voting against any restoration and were offering zero payment bids. All respondents could express their preferences in four choice situations. Before making concrete choices the interviewer explained the evaluation situation to ensure that the respondents fully understood the task.

Through the contingent valuation and the choice experiment the reasons for choices respondents made were looked for using follow-up questions. These helped to filter out responses not based on economic concerns.

| Features | Possible levels | | | |
|---|---|---|---|---|
| Flood frequency | Once every 5 years | Once every 25 years | Once every 50 years | Once every 100 years |
| Water quality | Medium  | Good  | | Very good  |
| Cost (monthly in the water bill) | 50 Ft – 0.2 EUR | 200 Ft – 0.73 EUR | 650 Ft – 2.36 EUR | 1000 Ft – 3.63 EUR |

*Figure 2*: Characteristics and the levels of the choice experiment method; use of pictograms to picture the benefits resulting from the improvements in water quality.

| | Case A | Case B | Current situation |
|---|---|---|---|
| Flood frequency | Once every 25 years | Once every 5 years | Once every 3 years |
| Water quality | Medium | Very good | Medium |
| Additional monthly water bill cost | 50 Ft | 1000 Ft | 0 Ft |

*Figure 3*: An example of the choice situation; the "current situation" is always between the choice situations.

# 4. Results

## 4.1. The results of the contingent valuation

As already described above, the maximum willingness to pay (WTP) was explored using a payment card where a total of thirty amounts appeared, starting from 0 up to 62,500 Ft and the possibility to indicate an 'other' amount. Most frequently the 5,000 and 10,000 Ft sums were marked. Altogether, 111 respondents out of 471 said that they would not pay anything to support the restoration program while 23 out of these 111 provided invalid answers . The results are detailed in the Table 1. The average WTP (excluding invalid answer) is slightly above that caculated for the entire sample: 6,533 vs. 6,212 Ft/month.

| Respondent maximum willingness to pay | | |
|---|---|---|
| | | frequency |
| WTP = 0 | 9 730 | 111 |
| Valid WTP = 0 | 117 170 | 88 |
| WTP > 0 | 14 | 357 |
| Valid positive WTP | 100 670 | 357 |
| Missing | 29 330 | 3 |
| Average WTP in the total sample | 202 060 | HUF 6,212 |
| Deviation | 11 970 | HUF 9,798 |
| Median | 95 820 | HUF 3,000 |
| Minimum (to the positive WTPs) | 380 | HUF 50 |
| Maximum | 70 200 | HUF 100,000 |
| N | 66 220 | 471 |
| Average WTP with the valid answers | 346 740 | HUF 6,533 |
| Deviaton | 204 690 | HUF 9,944 |
| Median | 8 600 | HUF 3,000 |
| Minimum (to the positive WTPs) | 6 050 | HUF 50 |
| Maximum | 1 320 | HUF 100,000 |
| valid N | 265 240 | 445 |
| Other woodlands and woody habitats (RA, RB, RC, RD, P45, P7) | 263 800 | 1.13 |

*Table 1*: The results of the maximum willingness to pay using the contingent valuation method.

Two of the results should be examined in detail and have relevance to environmental policy-making:

- the differences manifested in willingness to pay between two subgroups of the population; those who regularly enjoy the services offered by Által-streamlet ('users'), and those who do not use them ('non-users');
- the maximum willingness to pay for two programs, which increase the ratio of near-natural areas.

On the basis of economic theory, respondents who use the recreational and other facilities of the catchment area would dedicate on average a significantly higher amount to restore them to near-natural condition. The former would pay 7,094 Ft, while non-users would only pay ca. one-third, or 2,552 Ft annually (Table 2).

It is also on the basis of economic theory that we predict that greater improvements (i.e. a larger restoration area, which results usually higher welfare gains) will be coupled with a higher propensity to pay. Accordingly, increasing the rate of near-natural areas from the current 25% to 90%, in principle, leads to higher WTP. During the survey, respondents participated in approximately equal proportions in the two program scenarios. Although the average willingness to pay was higher for the better condition there is, statistically, no significant difference between the two scenarios. The average WTP is 6,385 Ft in the case of 50% scenario (€ 25.54), and 6,679 Ft (€ 26.71) in the 90% version case. That means the respondents could not distinguish the degree of change (no sensitivity to scope). It is likely that if the same respondents had been asked one after the other for WTP for the two scenarios, they would have been more sensitive to the scale of improvement.

| | Average WTP (HUF/ household/year) | Deviation |
|---|---|---|
| Users (N=390) | 7,094 | 10,401 |
| Non-users (N=55) | 2,552 | 3,921 |
| Flushes, transition mires and raised bogs (C1, C23) | 14 | 0.00 |

*Table 2*: The maximum willingness to pay of users and non-users.

### 4.2. The results of the choice experiment

In the case of the choice experiment, estimating the willingness to pay is much more complex than for the case of contingent valuation. Because of this, only the most important, easy to understand results are presented.

Each respondent could indicate their preferred situation from a total of four positions. From the total of 1,875 choices, 464 (25%) chose the current situation. This means that the three-quarters of the answers supported a development program. Results show that local population has a zero willingness to pay for reduction of flood frequency, so this outcome is of no value to the local population. In relation to water quality changes, WTP is positive. From a medium improvement to good was valued at EUR 21.2 (HUF 5,300)/household/year, while the value of an improvement from medium to good was EUR 42.5 (HUF 10,625)/household/year. From the results, various population utilities - meaning the implementation of individual program components in different combinations - can be calculated. Different scenarios can be developed (e.g. water quality changes from medium to good and flood frequency is reduced from once every 5 years to once every 50 years), to which in principle we can assign a total economic value (in our study, there was no point doing this since residents valued flood frequency reduction at zero, which is why different scenarios were valued the same, but this theoretical possibility is given).

## 5. Opportunities for further progress

The question arises, what can this research and its results be used for? Is a value obtained using this methodology exact and acceptable? The results cannot be considered perfectly accurate, nor even as correct amounts rounded to Forint. Rather, they provide guidance about the level of affected people's sacrifice, prepared to make for a given cause. Moreover, through such methodology, we can investigate whether social benefits are likely to exceed social costs. If the two values are very similar, proceeding with the intervention or program suggests underestimating benefits rather than the costs what are generally well known. Doing such a primary survey, as the case presented herein is very expensive, so it is important to create a wider database of cases of national evaluation. With such a database a lower budget, more feasible evaluation process becomes possible, such as benefits transfer and extrapolation from individual cases. In the short run this would require a great effort in Rural Development, but in the long run would repay the investment.

# 6. Literature

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