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HOW TO TAKE INTO ACCOUNT THE VALUES OF ECOSYSTEMS SERVICES OF VARIOUS HABITATS IN INTEGRATED COST-BENEFIT ANALYSIS?

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ABSTRACT

Global climate change may have substantially different local implications. Accordingly, the frequency and severity of extreme water related events (flood, inland inundation, and drought) may increase in Hungary. Therefore, adaptation is of crucial importance for the local population. One of the options to reduce the impact of such extreme water related events is to withhold and reserve excess water in natural areas, i.e. construct habitats that are less sensitive to changes in quantity, level, and dynamics of water. Changes in land use may, of course, imply loss of revenue for local farmers. Integrated cost-benefit analysis may be a useful tool to assess such cost implications and any possible benefits arising from improved ecosystem services of natural habitats. This assessment may enable us to better communicate to stakeholders what form of adaptation (i.e. land use change) to pursue and how it may bring best results. The primary aim of the research (in the frame of WateRisk project, TECH_08_A4/2-2008—0169) is to estimate the yearly value of ecosystem services per hectare of various habitats and include the resulting values in cost-benefit analysis of changes in the built (i.e. rural villages) and natural environment

Keywords: cost-benefit analysis, monetary valuation of natural habitats, land-use change, benefit transfer

INTRODUCTION

Although Rural development is a complex issue its potentials are not exploited properly. WateRisk project was started in 2006, (in full name: Extreme-risk area of water resources for effective, sustainable alternatives to the medium and long-term treatment). The duration time of the project is from 2009 till 2011 financed by NKTH (National Office for Research and Technology, TECH-08-A4/2-2008-0169). The final purpose of this project is to develop a water management decision support system (including a development of software and data system with a communication interface), which helps to find the best option of protection against the extreme water related events for villages along Tisza river[1].

In the research of altenatives cost-benefit analysis (CBA) is also applied, which is integrated, in order to endevaour to take wide range of social effects into account for

[1] The project leader is the Generalcom Engineering Ltd and other partners are: Corvinus University of Budapest, Budapest University of Technology and Economics, MTA Research Institute of Soil Science and Agricultural Chemistry, For the Living Tisza River Association Alliance

example, the value of ecosystem services of wetland habitats. According to the assumptions of this project the land use change is one opportunity to reduce the damage caused by extreme water related events. We have been studying the social effects of land-use change. From economical point of view these goods (non market goods) can be measured by the preferences of individuals, so the goal is to determine preferences in quantitative way. Since just a small part of ecosystem services own market price, which is often identified with the value of the ecosystem services. This is quite a wrong assumption because the value of the ecosystem services have to contain both market and non-market benefit. The majority of these services have not got any market or market price, therefore, during the decision making process (where we are calculating with costs and revenues) these non-market values are generally left out. The cost-benefit analysis can be found among the tools of economics, which counts (social) loss and benefits for a long period of time. CBA is a welfare theoretic method to trade off the advantageous and disadvantageous effects of a proposed project by measuring them in monetary terms (*Nunes et al.*, 2003). This new perspective of economics provides an opportunity to price those sevices and functions which have neither market nor market price, therefore, neither can we give any value in numbers. The monetary valuation methods give price to the non-market goods.

Finally we are looking for the net social utility of impacts on the environment, which we count by comparing various costs to benefits. In the study we produce an outline of the theoretical consideration and methodological background of the integrated CBA, as well as demonstrating its practical issues in the case of wetlands.

THE METHODOLOGICAL BACKGROUND OF THE ASSESSMENT OF COSTS AND BENEFITS

A traditionally cultivated agricultural field, as having land use change, can be transformed into a natural habitat, which process can also take place vica versa. Disregarding the way of transformation, our aim is to assess the social benefit of the change itself. It is relatively easy to find data of cost and income concerning the agricultural production but we have to consider that these transformed fields serve both market and non-market benefit, however, the latter is not included in the price of the crop.

It is needful to determine both market (i. e. the price of agricultural crops) and non-market value (ecosystem services) of various habitats. The proportion of these two values (market and non-market) is very different in various habitats, for example, the non-market value of a wetland is high while the non-market value of a plough-land is low (*Table 1*).

Table 1

Proportion of market and non market value of wetlands and plough lands

Natural Habitats	Values	
	Market value	Non-market value
Wetlands	Low	High
Plough-lands	High	Low

There are several ways of valuing changes in the ecosystem services according to literature of environmental economics. There are particular methods which identifies the costs of development with social benefits of development. These methods estimate the value which is not based on individual preferences, so economically these methods cannot be considered well established, hence these are useful to serve basic information in the decision making process. Those methods are regarded ideologically well established, which estimate ground of demand curve as the *stated preference* and the *revealed preference* methods. Practically this means that we are seeking people's WTP (willingness to pay) in relation to a given change. At the same time these methods can only bring about any proprer results if they use up a great deal of time and money.

The idea of benefit transfer (BT) emerged in the early 1980s. The benefit transfer method is used to estimate economic values for ecosystem services by transferring available information from studies already completed in another location and/or context. The idea behind the BT method is simple: transfer the benefit estimates from previous primary research *study sites* to the *policy site* under consideration (*Navrud*, 1996). The BT appears reasonable as it could obtain useful information without too much time and money, particularly for projects that do not require a high degree of accuracy.

This involves taking the results from one or more primary economic studies with estimated values for similar impacts, and modifying and transferring them to the project being evaluated. In cases where a high degree of precision is not critical, BT may provide useful information for decision-making. Frequently, it will be the only way of providing such information. The inclusion of environmental impacts in project appraisals has increased greatly in the last 10 years. Interest in benefit transfer has grown correspondingly and literature on the subject is now substantial (*Desvouges et al.*, 1992).

There are two main categories of BT mechanism (*Navrud*, 2000, 2004):

- the value transfers and
- the funtion transfers.

In practical benefit transfer studies, the value to be transferred can be either benefit or cost. It can also be a functional transfer or a single unit value transfer. If suitable functional relations and parameters are available, then a functional transfer can be more useful to reveal the dose-response relationship and provide valuable information on the impact of a change on one variable. However, as the functions obtained from travel cost method and contingent valuation method often have low coefficients, the transfer of such functions can lead to further uncertainties. In this case, the transfer of unit value can be more manageable as it can be adjusted as necessary.

There are a number of ways to perform value transfers:

- Unadjusted, single value transfers

  Here we simply transfer the value estimated from a study site to the policy site of interest. Ideally, the characterisics of the two sites would be very similar (i.e. same non-market service to be valued, same welfare measure used, similar biophysical and socio-economic characteristics).

- Adjusted, single value transferes
  Often, the study site and policy site will differ in characteristics. If the scale of sites differ, we can adjust by transferring unit values only (i.e. WTP/person/year, WTP/hectare/year).
- Average value transfers
  Here we collect a number of values estimated from previous study sites, calculate an average study site value and use this for the policy site.

  Function transfer is a more sophisticated approach of benefit transfers, where a value function is used to estimate a benefit for the policy site. There are two ways to perform function transfers:
- Use a study site function
  Here the value function (i.e. regression equation) from a study site is used for the policy site. The basic idea is to use this equation and plug-in the average income, age, and education characteristics of the policy site.
- Develop a benefit function (meta-analysis)
  The idea here is to collect information on a number of study sites and develop a regression equation to examine the factors that influence the benefit estimate.

Spash and Vatn (2006) refer to value transfer as within the context of information transfer in the natural and social sciences. This raises the question as to how value transfer can establish valid results within the unobservable nature of most ecosystem services values. Thereafter, the discussion on validity of values highlights the role of a wide range of biophysical and socio-economic variables. In all valuation applications the defensibility of the amounts will be the final test. At the end, the quality of primary studies determines the quality and applicability of the value transfer study. Commonly different aspects of transfer validity seem to have little attention, although specific conditions of similarity can be compiled from the literature.

Spash and Vatn (2006) found that low errors are expected when the following match at the two sites:

- the environmental service quantity, quality and their change,
- population, their characteristics and their use of services,
- market characteristics,
- institutional settings,
- time between primary value estimation and transfer, and
- geographical location.

The results are significantly influenced by the size of population which is taken into consideration during the aggregation (*Santos*, 1998; *Bateman et al.*, 2006).

THE CASE STUDY

Every year our country suffers serious economic damage, related to water management problems such as flood, inland inundation, drought etc. In the region of Hungarian Lowland the treatment of extreme water related evants is a particularly important challange. These events are gradually becoming more and more frequent according to certain climate forecasts (*Somlyódi*, 2000). These new challenges of the 21st century necessitate new methodological approaches. A key to this approach is water management in an integrated manner. Systems have become a primary objective of water management tasks in order to able to effectively address the flood, the inland and joint examination of the problem of drought. One of the solutions for extreme water related events is to store the excess water which later can be used for reducing drought damages. Alternatives for storing water: natural reservoirs, huge or medium sized artificial reservoirs, expand of inland inundation channels, filling the lowly areas at the time of flood etc. We are emphasizing one of the most natural solution: the storage of excess water in the nature, which involves new a approach, that is the land-use change. With the agricultural conversation the protection needs to be continued to step upon the valuable production areas, while on the less valuable areas (worthless plough land), the target is to mitigate the extent of damage. The land use change implies:

- appearance of bog habitats
- increasing the area of pasture-lands
- plantation of new forests (in order to decrease the effects of floods)
- part of the flood and inland waters can be kept in reservoirs and can be used for irrigation or fisheries
- the area of natural habitats would increase
- improvement of the soil's water balance
- ecosystem services would increase.

The Model of CBA

The primary purpose of the integrated cost-benefit analysis is to estimate the yearly value of ecosystem services per hectare of various habitats, so can see the decision-makers the consequences of land use change. We valuate five habitats based on Corine (Geographic Information System), which are: wetlands, lakes and rivers, forests, plough-lands, and grazing grounds. The size of habitats are determined by the applicaton of Corine.

Our model illustrates the *Table 2* and *Table 3*. We are researching the costs and revenues from the aspect of the society. The costs is classified into four categories, these are the cost of production, support, damage and wage. The categories has been formed by the available data, which provided by Research Institute of Agricultural Economics. The revenue is classified into two parts, one part originates from production, which has a market price and the other income has non-market value. One of the two revenue categories, originated from production, has a market price, while the other one is short of market price (non-market value). The total benefit of natural habitat equals the total revenue minus total cost so we can make desicion by the results. The costs and revenues are given monthly based on data. The non-market benefit of the habitats are given in yearly level in the literature, but this has to be modified 12 equal part i.e. monthly level (disregard the difference between the winter and sommer months).

The non-market value is calculated by the support of previous literature surveys and our survey. In previous literature surveys we have been looking for case studies of countries, which have similar culture and natural habitat to Hungary; primary surveys which gives WTP/hectare value (or we can calculate the WTP/hectare value based on the aggregated value and the size of habitat). Our empirical survey was a contingent valuation survey. The WTP of inhabitants for a program aimed to reduce the consequences of extreme water phenomena thereby increase wetlands. We have three pilot areas, along the Tisza River, these are Nagykörű, Bereg and Homokhátság. The annual WTP is 8738 HUF/houshold.

Table 2

Categories of the cost

Cost (HUF/hectare)	**Months**												
	I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.	XI.	XII.	∑
Production													
Support													
Damage (flood)													
Wage													
∑													

Table 3

Categories of the revenue

Revenue (HUF/hectare)	**Months**												
	I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.	XI.	XII.	∑
Production													
Other (Non-market)													
∑													

Our challange is to determine the non-market value of the habitats. The WTP of the collected studies were in different currencies and in different years, that's why we must homogenize all information. Values were transferred into current HUF, this means the previous WTP's have to be multiplied by both the inflation rates and by the purchasing power parity.

A practicle example in the case of wetlands

Based on the results of international studies it can be said that out of many habitats the non-market value of a wetland is especially high (*Oláh*, 2002). Enlargement of flood-basin causes varied land use (grazing groung, forest, orchard, reeds etc.) and ecosystem services can be revived (flood preventiom, replacement of groumd water, waste water treatment, cultural services etc.).

Table 4 and *Table 5* illustrate a practicle example of our model in the case of wetlands.

Table 4

The costs of wetlands

Cost (1000HUF/ha)	Months												
	I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.	XI.	XII.	∑
Production	0	0	0	0	0	0	0	0	0	0	0	0	0
Support	0	0	0	0	0	0	0	0	0	0	0	0	0
Damage (flood)	0	0	0	0	0	0	0	0	0	0	0	0	0
Wage	0	0	0	0	0	0	0	0	0	0	0	0	0
∑	0	0	0	0	0	0	0	0	0	0	0	0	**0**

Table 5

The revenues of wetland

Revenue (1000HUF/ha)	Months												
	I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.	XI.	XII.	∑
Production	0	0	0	0	0	0	0	0	0	0	0	0	0
Other (Non-market)	259.5	259.5	259.5	259.5	259.5	259.5	259.5	259.5	259.5	259.5	259.5	259.5	3114
∑	259.5	259.5	259.5	259.5	259.5	259.5	259.5	259.5	259.5	259.5	259.5	259.5	**3114**

The costs of the creation of wetlands and the revenue of the production are negligable. In order to determine non-market benefit, in this example, we used *Constanza's* (1997) famous study, which determines annual dollar/hectare value for different habitats and ecosystem services. This value was transformed by inflation rates and with the purchasing power parity for annual HUF(2009)/hectare value. Taking Costanza as a basis the non-market value of wetlands is 3 114 000 HUF(2009)/year. At present we are mentioning only one study for illustration and for the final fulfilment of CBA we intend to work up wide range of international surveys. In the case of wetlands we have own survey, so we can compare our results to the international ones.

CONCLUSION

The primary goal of the study is to estimate the yearly value of ecosystem services per hectare of various habitats and include the resulting values in cost-benefit analysis of changes in the built and natural environment. The costs and market income were determined based on data while the non-market benefit was estimated. Out of the five habitats just in the case of wetlands, have we primary survey on non-market benefit which was calculated by contingent valuation. With other habitats we used for assessment the benefit transfer method. The BT method is obviously not as good as primary non-market valuation studies, however, they've been promoted as a usefool tool quantifying environmental benefits, when there is a limited budget and limited time.

We are still working on the study. The followings are still in progress:

- Collecting literatre valuation survey,
- The transformation of previous WTP/hectare values transform for the present,
- In our survey WTP/houshold has to be transformed to WTP/hectare.

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