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Land use change as an opportunity to decrease the consequences of extreme weather events: a case study of the Tisza Valley in Hungary

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Abstract: There are many reasons that the losses caused by extreme weather events are escalating year by year in Hungary. They include Hungary's geographical characteristics, climate change, river regulation and the expansion of cultivated land. Changes in land use have hugely damaged natural capital, primarily decreasing the area of wetland. Wetlands are multiple-value resources and just one of their functions in the ecosystem is flood regulation. This type of habitat is able to store excess water which can be used in times of drought. At the same time, appropriate land-use (such as increasing the area of wetlands) can help address extreme weather events and increase the amount of natural capital. During the research this paper describes, the social impacts of different kinds of land-use were examined using cost-benefit analysis, contingent valuation and the benefit transfer method. These methods are able to assist with environmentally sustainable decision making as they can be used to show the social preferences for different types of habitats.

Keywords: land-use change, cost-benefit analysis, ecosystem services of wetlands, contingent valuation, benefit transfer

1. Introduction

The future of Hungarian water resources will be determined by a combination of external and domestic, environmental, social and political processes such as climate change, regional and rural development. Demand for reliable supplies of water for climate change adaptation will rise,

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not only in Hungary but across the world as well (RAMSAR, 2012). The economic and social costs of extreme weather events related to climate change – particularly flooding – may rise in the future, according to certain forecasts (IPCC, 2007 in Bouwer et al., 2010). Lakes, rivers and wetlands are the most sensitive of all habitats to changes in climate (UK NEA, 2011). Due to its geographical conditions and climate extremes (e.g. floods, inland inundation and droughts) the water balance is not stable in Hungary. Every year the country suffers significant economic damage from water management problems caused by both the abundance and the lack of water, which can occur in the same region in the same year. Adaptation to such events is of crucial importance for the local population which is why the WateRisk project was launched .

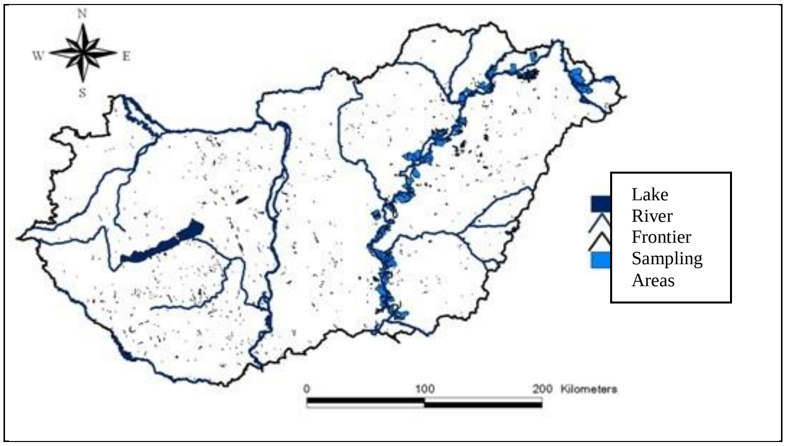
The project described in this paper was founded on the belief that land-use change represents an opportunity to reduce the damage caused by extreme water-related events. One of the options for lessening the impacts of such extreme water phenomena is to withhold and reserve the 'excess' water that accumulates in natural areas through changing land use (i.e. by constructing habitats which are less sensitive to changes in the quantity, the level and the dynamics of water). Boggy and marshy habitats can be constructed (or assisted to evolve) in low-lying areas, with attendant positive effects on biodiversity and ecosystem services (ES) which are essential to humanity, but currently dramatically decreasing (Millennium Ecosystem Assessment [MEA], 2005). The drivers of these losses include habitat change (e.g. land use changes, physical modification of rivers) and climate change. Both the expansion and intensification of the use of cultivated lands increased on a global scale by four or five times in the period from the 1700s to the 1980s and forests, grasslands and wetlands have been damaged (Barral et al., 2012). Hungarian territory is not an exception to this global trend. Over the past 130 years, canalisation, river regulation and the uptake of intensive methods of cultivation have resulted in extreme changes to the Tisza River Basin. 90% of associated wetlands have been lost and the river has been shortened by two-thirds (Flachner, 2008). As humanity may be endangered by irreversible changes to the environment there is an essential need to apply environmental valuation methods that take the interests of nature into consideration in decision making processes. In this research into alternatives for land use change, cost-benefit analysis (CBA) was applied. We consider this type of analysis to be integrated in the sense that it endeavours to take a wide range of social effects into account, even though the value of such effects can only be quantified with difficulty. An outstanding example of this involves putting a value on the ecosystem services of wetlands.

The aims of this study are to (i) introduce the environmental-economic valuation model, (ii) examine the social preferences for the increasing wetland areas and the reduction of the consequences extreme water phenomena, (iii) make further remarks on the monetary evaluation process and CBA (iiii) give brief suggestions for the possible future methodological improvements. The paper is divided into four parts. The first section introduces the sample area, the wetlands of the Tisza Valley and the related ecosystem services. The second part describes the methodological background to the research which consisted of the application of CBA, Contingent Valuation (CV) and Benefit Transfer (BT) methodology. Both of the former monetary valuation methods support decision making in environmental projects through expressing the advantages and disadvantages of alternatives in units of money. Through this process it becomes easier to compare alternatives, although one of the disadvantages is that qualitative factors are typically of little account in decision making. The last part of the paper contains empirical findings and a summary of our conclusions.

2. The case study area and land-use change

The sample areas which extend throughout the 1500 km^2 of the case study area are contained in the three sub-regions of Nagykörű, Bereg and Homokhátság (see Fig. 1). These areas along the River Tisza were sustainably connected to the river before the river was regulated. Land use in these areas was examined using the CORINE (Coordination of Information on the Environment) database. It is evident that there have been significant changes to land cover in these areas as a result of human activity: 48% of sample areas are cropland and only 5% are covered by forest (Koncsos et al., 2011, Muzelák and Koncsos, 2012). The native environment along the River Tisza originally included forests of elm, ash and oak. Due to the effect of human activities, this vegetation has changed: meadows, groves and the forested swamps of the primary and secondary floodplains have partially and in some cases fully disappeared.

Figure 1. Sampling areas along the river Tisza



Source: Koncsos et al., (2011:204).

According to the categorisation system used by MEA (2005), present day land cover is largely dominated by 'provisioning services' (food provision through intensive farming). 'Regulating and supporting functions' which are provided by wetlands and forested swamps comprise only 6.5% of pilot areas. 58% of the sample area is drought-prone and 93% are flood (and 92% inland inundation) prone (Koncsos et al., 2011). Drought and inundation are both risk factors in these areas and risks may increase in the future. The quantity of regulation and supporting services is presently decreasing. In addition, provisioning is likely to decrease in the long-term (thus the need for irrigation will increase) because the methods of intensive cultivation that are employed are not sustainable in the long term. Table 1 shows the quantity of both current and preferred ecosystem services provided by intensive cultivation.

Table 1. The dominant ecosystem services of the sample areas at present and after the desirable land-use changes

Ecosystem services			
Provisioning	**Regulation**	**Supporting**	**Cultural**
Currently dominant ecosystem services of the sample areas			
Food (Crop, Fruit, Animals)	Crop pollination	Nutrient cycling	Recreation
Fresh water			
Genetic material			
Desirable dominant ecosystem services of the sample areas			
Food (Fruit, Crop)	Regulation of natural hazards (floods, storm)	Soil formation	Recreation
Fresh water	Climate regulation and Carbon sequestration	Nutrient-cycling	Spiritual value
Fibre, fuel, wood	Water quality regulation, water purification, detoxification of water		Aesthetic
Genetic material			Educational

Source: Authors' construction based on MEA (2005) and Koncsos et al. (2011).

Changing land-use is one option for reducing the risk caused by extreme water-related events and could be done through increasing subsidies and regulating ecosystem services. This option would require capturing and holding excess water through constructing habitats such as bogs and forested swamps which are less sensitive to changes in the quantity, the level and the dynamics of water and which increase the range and quantity of ecosystem services. Designing a system of mosaic patterns of land use and using surface water to create forested swamps would be an ideal way to meet these goals but would require that forested areas cover a considerably larger area than they do now. In all areas of human life habitats and their services, particularly wetlands, are of primary importance since they produce 15% of the world's natural capital (Costanza et al., 1997). Services provided by natural and modified ecosystems have material and non-material benefits for the whole of humanity (MEA, 2003). The material goods produced by ecosystems are easy to identify (e.g. plants and animals) but the services they provide generally appear in more complex forms, such as the flood regulation function of wetlands. Westman originally examined natural services in 1977 and the concept of 'Ecosystem Services' was introduced by Ehrlich and Ehrlich in 1981 (Gonczlik, 2004). Since that time several pieces of research have attempted to quantify (Costanza et al. 1997, Troy and Wilson 2006, de Groot et al. 2012) and categorize (de Groot et al. 2002, MEA 2005, Wallace 2007) these goods and services.

The estimates that have emerged are helping to maintain the environment in the long term. The idea that wetlands provide ecosystem services is relatively new because wetlands have historically been considered less valuable areas and were reclaimed in favour of cropland. Nowadays this perspective is changing and the new approach understands that this habitat provides a wide range of extremely valuable services to society (Mitsch and Gosselink, 2000).

Many types of wetlands exist across the world. They include the Hungarian lowland bogs, marshes, swamps and flood/inundation areas (secondary floodplains). Swamps are a type of wetland that are dominated by water-resistant woody plants and serve a vital role in flood protection and nutrient removal. Floodplain forests are often inundated with floodwater from nearby rivers and streams. In very dry years they may represent the only non-geological water source for miles and their existence is critical to the survival of wetland-dependent species. The growing unpredictability of water availability is increasing the need for additional water storage. The Ramsar Convention (Iran, Ramsar, 1971) is an intergovernmental treaty that embodies the commitments of its member countries to maintain the ecological character of their Wetlands of International Importance and to plan for the "wise use", or sustainable use, of all of the wetlands within their territory (RAMSAR, 2012).

There is a direct relationship between land-use and natural capital. Present-day land-use in Hungary is not adjusted to the risk factors and the current status of environmental conditions hence it is not sustainable in the long term. Decision makers must take into account not only land use and water regulation but also the amount of natural capital. A growing concern in land-use policy is how to equally incorporate economic, social indicators and ecosystem-service valuations in a well-balanced decision-making matrix (Viglizzo et al., 2012). According to the results of studies into the valuation of ecosystem services, wetland areas play a leading role in producing social benefits through their complex hydrological, biogeochemical and ecological functions (Brouwer et al., 1999). In the case of lowlands land-use changes can offer multiple benefits to society, partially due to their ability to decrease the cost of flooding and partly because these areas can ensure that the water supply to a region is maintained (through the storage capacity of flooded areas). Decision support systems can help in planning for a long-term sustainable landscape: hydrological and environmental economic models are based on local parameters which can determine how natural capital (and its attendant social benefits) changes according to different types of land use.

3. The methodological background to CBA

Policy makers need information about the economic consequences of the decisions they make. CBA, firmly grounded in economic theory, has traditionally been an important tool for informing politicians, although it is limited by the need for monetised inputs (Brander et al., 2012). CBA evaluates potential programs according to the costs and benefits of the consequences of the programs: costs have negative and benefits positive value (Baum, 2012). CBA can help with deciding “whether the benefits of a particular action are bigger than the costs judged from the viewpoint of the society as a whole” (Hanley and Barbier, 2009:1). The CBA process involves the following stages: (i) project definition; (ii) identification of the physical impacts of the project; (iii) valuing impacts; (iiii) discounting of cost and benefit flows; (v) applying the net present value test; and, (vi) sensitivity analysis (Hanley and Barbier, 2009). Baum (2012) presents a value typology of CBA which identifies three forms; ‘money-based CBA’ that measures costs and benefits in monetary units; ‘social welfare-based CBA’ which defines costs and benefits in terms of social welfare in any numeraire; and, ‘intrinsic value-based CBA’ that defines cost and benefits in terms of any choice of intrinsic value.

The goal of integrated cost-benefit analysis is to identify the social utility of different kinds of land use and to integrate any risk analysis. Calculating benefits and costs should be done by taking multiple dimensions into account (i.e. considering the types of habitats that are being valued and the existence of cultivated areas) along with their costs and benefits. In the course of cost-benefit analysis, five main habitats can be evaluated according to the CORINE system: ploughland, pasture, forests, surface water (lakes and rivers) and wetlands. It should be remembered that a traditionally-cultivated agricultural field can be transformed into natural habitat, and vice versa. Disregarding the method of transformation, the aim is to assess the social benefit of the change itself. It is relatively easy to find data about cost and income for agricultural production but one must also consider that transformed fields (for example) provide both market and non-market benefits, although the latter are not included in the price of the crops. Thus it is necessary to determine both the market (i.e. price of agricultural crops) and the non-market values (ecosystem services) of various habitats. The ratio of the two values (market and non-market) will be very different for various habitats (for example, the non-market value of a wetland is typically high, while the non-market value of plough-land is low [Marjainé Szerényi et al., 2011]). Table 2 shows how an integrated CBA can be differentiated in terms of assessing costs (private and social e.g. financial support, funds, crop disaster payment), benefits (private and social: e.g. ecosystem services).

Table 2. Dimensions of integrated CBA.

Categories	Private	Social
Cost	Production	Financial support
Benefit	Production	Ecosystem services
Private and Social Balance	(+/-)	(+/-)
Total Social Balance	(+/-)	

Source: Authors' own construction.

Table 2 presents the method used for determining the private and social balances. Private production costs have been subtracted from private production benefits. This leaves the balance available for private production. Determination of the social balance was done using a similar approach, meaning that the social costs were subtracted from the estimated social values of eco services (this contains private income and therefore can be used to make corrections). Finally, these two balances were summed with the employment effect (further modified by applying local factors) resulting in the value of the estimated social balance, which represents the social and the ecological value of a given area at a given time. Using the total value it is possible to compare different types of land use and to decide whether land use changes should be undertaken. As can be seen in Table 2, the summarized balance comes from the difference between private and social costs and benefits. The revenue of private production minus the cost of private production gives the private balance, while the benefit of ecosystem services minus the cost of public support gives the social balance. These two balances allow us to determine the final balance. The social benefits of ecosystem services contain some private benefits as well, but this is corrected for. Data about the private sector and public support were provided by the Hungarian Research Institute of Agricultural Economics. The total balance was calculated for all five habitats so the monetary value of land-use could be compared.

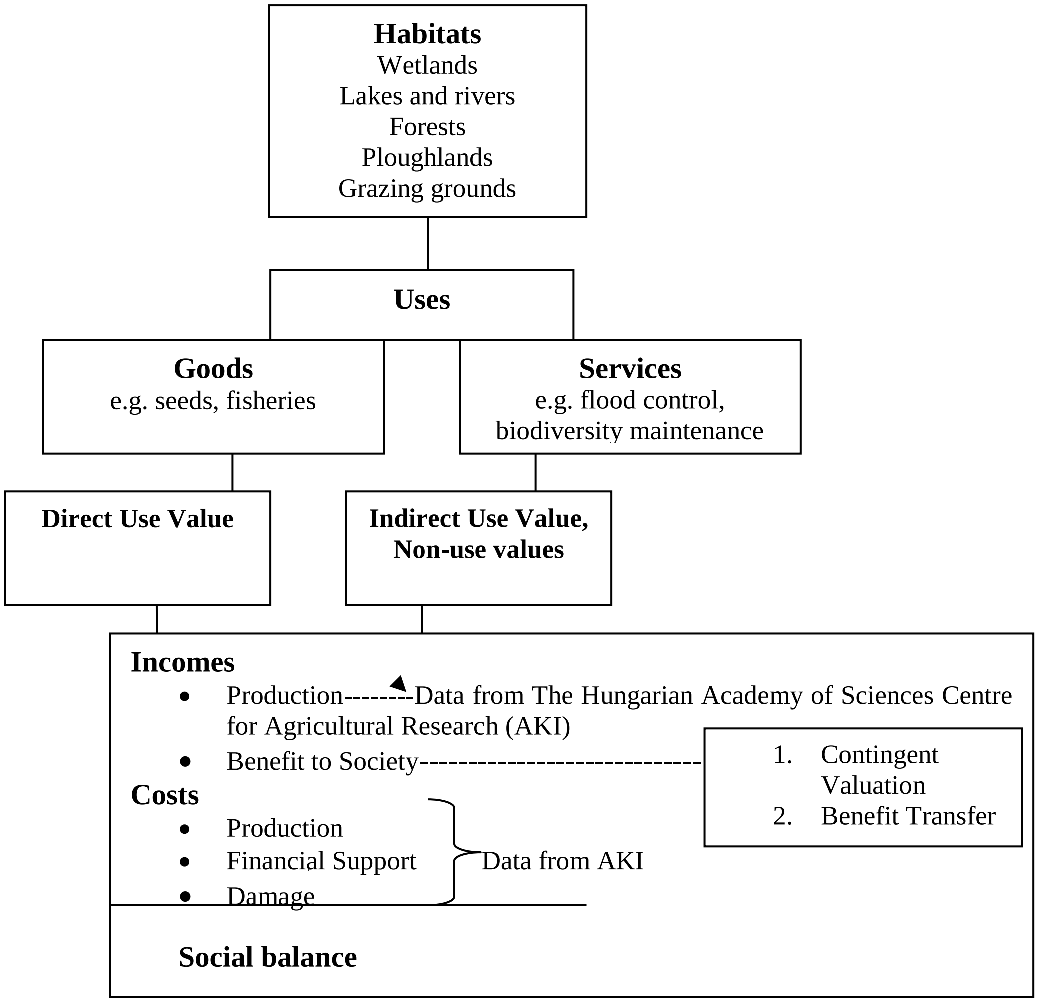
When goods have no price, their value is seldom taken into account in decision making (Ansink et al., 2008). Price has become one of the most frequently-used indicators in ES research. Provisioning services can be easily quantified using market prices (e.g. the cost of food or wood), but for regulating and cultural services it is more difficult to obtain an exact value because these services do not have a market price. Estimations of market value have only been undertaken for a few regulating services (e.g. the cost of engineering projects for flow regulation, water cleaning, etc.). There are a lot of problems concerning pricing ES: as no markets exist for the majority of ES they cannot be clearly identified and quantified and the economic methods for pricing single services in monetary terms are mainly subjective (Viglizzo et al., 2012).

The meaning of the word 'value' is subjective; individual perceptions determine what is valuable and what the preferences of societies are (Mitsch and Gosselink, 2000). Thus ES are only 'valuable' if society considers them to be so. This fact can be determined according to demand for ES; the proxy for this is their economic value which can be measured with the help of environmental valuation methods. Ecological characteristics (e.g. size, location, pH, geology) originate from structure (biomass, soils, profile) and from the processes (photosynthesis) that create the ecosystem functions. Wetland uses (goods and services) and their economic value (direct use value, indirect use value, non-use values) thus come from their functions (Turner et al., 2000). The open-access nature and the public-good characteristic of wetlands can result in their undervaluation when decisions are made about their use and conservation (Brander et al., 2006).

Figure 2 demonstrates the process of the economic valuation of ecosystem services. According to the literature there are several ways to assess changes in ecosystem services. Firstly, there are procedures that identify benefits as development costs. These methods do not estimate values on the basis of individual preferences so from the perspective of economics they cannot be considered theoretically well-founded, but they provide good basic information for use in decision making. The more theoretically sound group of methodologies estimate a demand curve: these are stated preference (SP) and revealed preference (RP) procedures. Two main types of RP approach are the hedonic pricing (HP) and the travel cost method (TCM). A TCM is not relevant in this research because it is only suitable for evaluating such natural goods wherein the recreational value (e.g. national parks, public footpaths etc.) is the most dominant part of the total economic value. The basic assumptions of the HP is that people's valuation of environmental attributes can be inferred from the amount they are willing to pay for these attributes through housing market (Hanley et al., 2001). There is, however, a relation between the environmental good and the housing market in this study (e.g. the flood risk can cause decreasing in the prices of properties) although this cannot be applied in the case of Hungary due to the shortage of data (Marjainé Szerényi, 2005). The contingent valuation (CV) is one of the stated preference method, which examines people's willingness to pay (WTP) for a certain change (in this case, an increase in wetland habitat and a decrease in the consequences of extreme water phenomena).

Using the SP and RP methods generally demands a lot of money and time and when these resources are lacking, the benefits transfer (BT) method can be employed. In cases where a high degree of precision is not critical, BT may provide useful information for decision-making. Often, it is the only way of supplying information. During our research into wetlands CV and BT were used, but for other habitats only BT was used to cut down on costs due to our limited budget. Three complex studies (Costanza, 1997; UK NEA 2011; de Groot et al., 2012) that offer monetized values for a wide range of habitats were identified; the rest of the studies that are presented in the literature only evaluated one certain habitat or a specific ecosystem service. Many of these data were used and compared. The summarized outcome of the CBA can be used as a criterion in the decision making process about whether land use change should take place.

Figure 2. Model of the environmental valuation of various habitats.



Source: Authors' own construction**.**

4. The methodological background to CV and BT methodology

CV is one of the oldest methods still in use for evaluating changes in natural resources (for a detailed overview see Mitchell and Carson, 1989; Marjainé Szerényi, 2005) and thus in terms of methodology it is the most advanced stated preference procedure. It is a direct method, meaning that people are asked directly about their WTP or willingness to accept (WTA) compensation, so it is always based on a questionnaire survey. There are two kinds of approaches for measuring the economic value of something, the WTP or WTA. Willingness to pay measures the maximum amount an individual would be willing to pay to secure the change or the minimum amount of compensation one would be willing to accept to forgo it (Hanley et al., 2001). On the recommendation of the National Oceanic and Atmospheric Administration (NOAA) committee WTP is applied in our survey (Arrow et al., 1993), leading to more reliable results than WTA.

Since this is the most well-known method, its application is still the most widespread in a research. The range of goods that can be evaluated using CV is almost unlimited because questions about any changes can be written into the survey questionnaires, even those that are hypothetical. However, it is important that any changes that are evaluated should be as credible as possible. With CV only a whole program can be evaluated; individual components cannot be evaluated separately. One disadvantage of the method is that changes that are evaluated are hypothetical, along with the payment of any money that is offered. This fact can distort WTP in an upward direction (Marjainé Szerényi, 2005). Respondents' preferences and willingness to pay for the expansion of near-natural areas were evaluated using this method. Expanding near natural areas is a land use change that can damp down and balance extreme flow regime events along the river (the onsite, natural storage of water that happens after major floods may shorten periods of drought and decrease water shortages and the severity of adverse consequences).

Benefit transfer takes previous primary research findings from one biophysical, economic, temporal, and spatial situation (study site) and transfers them to another (policy site). The first benefit transfers appeared in the 1980s (Wilson and Hoehn, 2006). According to Adamowitz (2004) there has been a significant increase in the past 40 years in the number of environmental valuation studies. In parallel with evaluation studies, valuation databases have appeared. The Canadian EVRI (Environmental Valuation Reference Inventory) and the Australian Envalue were the pioneers in this field. The four most popular databases in addition to the two mentioned above are the Ecosystem Services Database (ESD) and The Review of Externality Database (RED) (McComb et al., 2006). In 2006 a special issue of the Journal of Ecological Economics was devoted to BT which indicates the rapid development of this methodology. Applying BT in decision-making appears to be reasonable as it can be used to obtain useful information without spending too much time and money. It is particularly useful for decision making when a high degree of accuracy is not required (Pearce et al., 2002).

There are three main value transfer categories employed in BT: (i) unit value transfer (without or with adjustments; usually for income differences); (ii) value function transfer (using an estimated value function from an individual primary study); and, (iii) meta-analytic function transfer (using a value function estimated from the results of multiple primary studies). For a number of reasons the application of any of these value transfer methods may result in significant transfer errors; i.e. transferred values may differ significantly from the actual value of the ecosystem under consideration (De Groot et al., 2012).

Spash and Vatn (2006) refer to value transfer within the context of information transfer in the natural and social sciences and raise questions about its validity due to the unobservable nature of most ecosystem services values. The quality of primary studies determines the quality and applicability of any value transfer study.

Navrud and Ready (2006) found that the value of an environmental good is determined by three different sets of factors: (i) the characteristics of the good itself (quality and quantity); (ii) the context within which the good exists (availability of substitutes etc.); and, (iii) the characteristics of the users who value the good (income, age, experience). When using the BT method it is important to consider the differences between the goods and the context. A large amount of detail about the study site is necessary for any application of BT. The minimum reporting requirements are identified by Loomis and Rosenberger (2006) as being:

- Reporting information about the valued commodity (i.e. site definitions and characteristics, facilities, information of site location, presentation of valuation questions/scenarios).
- Reporting information about the market area and affected population (e.g. income, age, education, gender, local environmental attitudes, people's lifestyle choices, attitudes and preferences).
- Reporting of welfare measures: this means clarification of how WTP was calculated.

5. The Circumstances of our CV survey

In 2010 a CVM-survey was carried out among the inhabitants of three sub-regions in the east of Hungary: Nagykörű, Bereg and Homokhátság. Altogether, 325 people participated. The questionnaire consisted of three main parts: (i) the first section contained general attitude questions; (ii) the second examined willingness to pay for the expansion of wetland areas; the last section (iii) focused on the present and likely future attitudes of respondents concerning social-economic-environmental issues. Information about socio-economic variables was also collected.

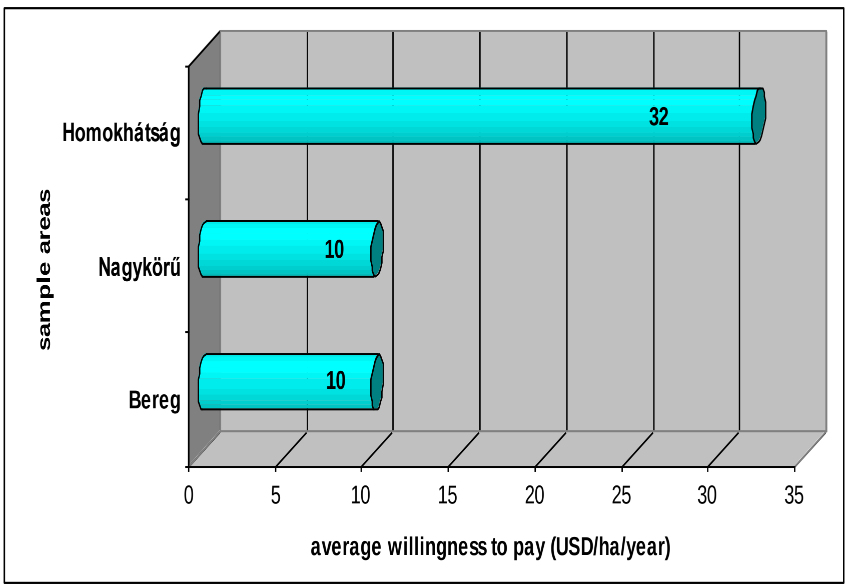
The first step in the method was the creation of a hypothetical market. In this framework the current characteristics of the assessed ecosystem services along with a program containing the required changes and the hypothetical monetary contributions of local people were presented. In the three sub-regions virtually the same program was used; only a few changes had to be made to tailor the program of measures to each region to make it more realistic and believable. The rate of change was the same everywhere. The questionnaire contained a brief description of each of the three sub-regions, starting with the current land use situation and ending with a description of the program (Marjainé Szerényi et al., 2011). The essence of the program was a change in land use which would be accomplished through the help of the so-called Tisza River Development Centre. The changes in the characteristics of the three regions were formulated as follows: if a more mosaic-like landscape were to develop, there would be fewer instances of drought, the frequency and severity of floods would decrease and the proportion of wetland areas would increase (from 10% to 30%). Respondents were given the information that the execution of program could be financed partly through assistance from the state and partly through the contribution of local people. The willingness to pay question was presented as follows (Marjainé Szerényi et al., 2011): "What would be the maximum amount that your household would be willing to pay annually (for the next 10 years) in order to create a balanced water management system that could be implemented through land use change in the Nagykörű/Homokhátság/Bereg region? Please remember when you answer that your income could be spent for many other purposes as well!".

6. Empirical results

6.1 The results of CV

After examining the methodological constraints and recommendations defined in the literature (for example, examining the responses of those who indicate zero WTP) estimating WTP was the main task of the survey. In our case, WTP was averaged at 60 USD per year per household for the total sample (equivalent to 0.547 % of average net income per year). Regarding the averages there were differences between sub-regions: the inhabitants of the Homokhátság sub-region offered 77 USD on an annual basis, significantly more than the WTP of respondents from other two sub-regions. The average WTP of inhabitants in Nagykörű was 50 USD. Respondents from Bereg offered the lowest: 45 USD on average (the last two sums do not differ statistically). The significant difference disappears when the ratio of relative income offers are compared, although the order remains the same. WTP/household was measured at a local, a county and at a country level and WTP/ha values were calculated from these values. Based on these results, and taking into account the number of stakeholders, what benefit the implementation of the program generally offers to local inhabitants can be determined through aggregation. After local aggregation WTP was identified as being 10 USD/ha/year in Bereg, 10 USD/ha/year in Nagykörű and 32 USD/ha/year in Homokhátság (see Fig. 3.) (PPP based on Penn World Table)[1]. On a country level 100% of the average WTP for pilot areas was used for local people, 80% of this for people living in the directly affected counties and 30% of WTP for people who live in other areas of Hungary. After the aggregation process the average WTP/ha at a country level was determined to be 205 USD/ha/year.

Figure 3. Average WTP for the sample areas (USD/ha/year).



Source: Authors' construction.

6.2 Literature used for the Benefit Transfer Method

We examined case studies from the literature for countries which have a similar culture, climate and habitat to Hungary and sought out mainly primary surveys that provided results in units of WTP/hectare (or from which we could calculate and standardize WTP/hectare based on

[1] https://pwt.sas.upenn.edu/php_site/pwt71/pwt71_form_test.php.

the aggregated value and size of the area). The WTPs of the collected studies were in different currencies and for different years so standardization was undertaken. WTP was standardised as units of USD for 2010: this meant that the earlier WTP findings had to be multiplied by both the inflation rate and by purchasing power parity (PPP). The Penn World Wide Table includes a list of PPP for 168 countries based on data from the OECD and the Word Bank (Ready and Navrud, 2006).

There exists substantial literature about wetland valuation (Pate and Loomis, 1995; Gren et al., 1995; Kazmierczak, 2001; Woodward and Wui, 2001; Jenkins et al., 2010) and a considerable number of these studies were reviewed. However, only a few proved to be adaptable for our purposes since we needed data in units of WTP/hectare and in many cases findings were provided in units of WTP/household. This caused us some trouble as the studies did not provide adequate data for converting from one unit to the other (for example, they did not specify the size of the sample area or the aggregated population size, etc). Another challenge was that some of the studies did not evaluate complex habitats but only specified 'ecosystem services', meaning that the findings included a wide range of different values.

Brander et al. (2006) distinguished between average and marginal values, both of which can be expressed as a monetary value per hectare. The majority of wetland valuation studies estimate total or average wetland value but there are also a large number of estimates for marginal wetland value. Small changes in wetlands should be valued through examining WTP for marginal changes, whereas average values may be useful for comparing the aggregate value of a wetland area to a larger area. "Expressing wetland values in per hectare terms gives the impression that each hectare in a wetland is equally productive, i.e., that wetlands exhibit constant returns to scale or equivalently that the marginal wetland value is equal to average wetland value" (Brander et al., 2006, p. 12.). Here, the author assumes that it is possible to convert marginal values into average values, or vice versa, despite the fact that this is methodologically impossible. Table 3 summarizes the main features of the literature that was reviewed and their findings as annual monetized values in USD; these figures were used in the final evaluation of the Hungarian wetlands.

Table 3. Published research on the economic value of wetlands

Author/Date	Location/ Habitat	Valuation method	Marginal USD(2010)/ha/year	Average USD(2010)/ha/year
Kosz (1997)	Donau-Auen National Park	CV	-	22500
Brander et al (2006)	General wetlands	Meta-analysis	4000	-
Brander et al (2012)	General wetlands, climate change scenario	Meta-analysis	7500	-
UK NEA (2011)	Inland wetlands biodiversity	Stated preference methods	500	-
De Groot et al. (2012)	Inland wetlands	Meta-analysis	-	27000
Costanza	ES and biomes around the world	Synthesized results of previous studies, methods based on demand curve	-	21700

Source: Authors' construction.

De Groot et al.'s (2012) publication provides an overview of the value of the ecosystem services of the ten main biomes identified in the Ecosystem Service Value Database (ESVD), expressed in monetary units. It suggests that most ES value remains outside the market and, correspondingly, the over-exploitation of ecosystems is continuing. Many of the positive externalities of ecosystems significantly decrease after land use conversion. Better accounting for the public goods and services provided by ecosystems is crucial for improving decision making for biodiversity conservation.

Brander et al. (2006, 2012) carried out research into wetlands using meta-analysis. Their 2012 paper contains reference to the likely impacts of climate change on the wetlands of Europe between 2000 and 2050. This study predicts reductions in size of wetland area of up to 7720 ha and 32.95 million USD losses in the value of ES for Hungary. The paper proposes a methodology for scaling up ecosystem service values in order to estimate the welfare effects of changes in ecosystems at a larger geographical scale. Brander et al. (2006) collected 190 wetland valuation studies in order to undertake a more comprehensive meta-analysis of valuation research. The studies examined include research into tropical wetlands (mangroves) and contain estimates derived from diverse valuation methodologies that were employed to examine a broad range of wetland services (e.g. the value of biodiversity). The authors found that the socio-economic variables (i.e. income and population density) that are often omitted from such analyses are important for explaining the value that is attributed to wetlands (Brander et al., 2006). The UK NEA Technical report (2011) is also a well-established, complex, recent analysis that evaluated various ecosystem services and habitats in the UK. Research by Kosz (1996) evaluated the ES of Donau-Auen National Park with and without hydropower electricity in order to estimate the effect of a hydropower project. Methods included CBA including a CV wetland valuation. The author found that inhabitants would be willing to pay 329.5 ATS (average 22500 USD) to conserve the 1150 ha National Park and to prevent the establishment of a hydropower station.

7. Conclusions, remarks and a practical example of CBA for wetlands

Our survey of related literature and our own research carried out using contingent valuation arrive at the fact that WTP is affected by many factors, amongst them the income of those who are surveyed. In Table 4 the outcomes of the different methodologies are summarized and complemented by the sum identified in research into wetlands by Costanza et al. (1997), which was also corrected using inflation rates and purchasing power parity. There are three categories in Table 4: our own survey WTP, total marginal BT WTP and total average BT WTP. Brander et al. (2006) remarks that it is impossible to convert marginal WTP to average WTP and in their study these values should be considered equal. In our own research the WTP is a marginal value (205 USD/ha/year), thus making it easier to compare with the marginal benefit transfer value (500-7500 USD/ha/year). The difference between the BT-derived WTP and our own outcome is quite significant and the reason for this is the following: regarding the socio-economic and the geographical context, the positive effect of the income variable (GDP per capita) indicates that wetland ecosystem services are more highly evaluated in countries with higher incomes (Brander et al., 2006). This explains why Hungarian WTP is less than the total WTP. Besides our own research it was necessary to examine results from other similar studies because there have been no surveys carried out to evaluate other habitats (e.g. woods, rivers, ploughlands and grazing grounds), mainly due to the lack of sources.

The considerable differences distinctly exemplify the instability inherent in the findings and can be mainly attributed to the inaccuracy of the benefit transfer in capturing information about the following items:

- different socio-economic environments (variable incomes of respondents, level of environmental consciousness);
- the examined good; our purpose was to carry out a complex evaluation of the function of wetlands as a habitat but in the majority of the literature that we reviewed only one ecosystem service (not a complex habitat) was evaluated and no accurate definition of the valued service was provided;

Additionally, double counting and averaging of the results found in the literature also raise the level of uncertainty.

Table 4. Summary of findings (rounded).

Research	WTP (USD, 2010/ha/year)
Authors' research, country level WTP (rounded)	205
Total marginal BT WTP	500-7500
Total average BT WTP	21700-27000

Source: Authors' own construction

Table 5 shows the summarized balance for wetlands in USD (2010)/ha and suggests that for this land use the private cost, the social cost and the private benefit are negligible. These rubrics are of course different for other habitats. Taking our own findings and the marginal BT-derived WTP as a basis, the non-market value and a total balance of wetlands are 205-7500 USD/ha. According to some literature, the economic value of wetlands is so high that it would be reasonable to say that every piece of land should be changed into a wetland, a conclusion which is quite absurd due to the existence of climate and hydrology-related barriers on a macro scale This phenomenon is called the ecosystem substitution paradox (Mitsch and Gosselink, 2000). Some kind of balance has to be found between nature and people so they can cooperate symbiotically. When determining the ideal size of wetlands it is necessary to seek a situation where an area is still able to fulfil its ecological functions but at the same time offers value to society.

Table 5. The dimensions of integrated CBA.

Categories (USD/ha/year)	**Private**	**Social**
Cost	Production: 0	Public support:0
Benefit	Production: 0	Ecosystem services (USD/ha/year) 1. 205 2. 500-7500 3. 21700-27000
Private and Social Balance	0	205-7500
Total balance	**205-7500**	

Source: Author's own construction

These findings contain a high level of uncertainty due to the methodology and the data used, thus their utility rather derives from their use in comparisons of social preferences for different kind of habitats and land-use. Obviously a greater preference for one type of land-use is desirable and this information can be taken into account in 'environmental-friendly' decision making.

Mitsch and Gosselink (2000) suggest that the optimum percentage of wetlands in a landscape might be approximately 3–7% (average 5% in a temperate-zone). To determine this proportion more precisely, however, the size of the population living near to the wetland has to be taken into account, as well local specificities.

In the three lowland regions examined in our research the proportion of the area that is waterlogged is greater than the formerly-mentioned optimum average. Consequently, attention is drawn to the fact that it is local conditions that should primarily be considered, and the findings of international research must only be a secondary consideration. Uncertainty about the unit value of wetland services can be reduced through undertaking sensitivity analysis, as well as by more precisely determining the desired size of the habitats concerned.

The monetary valuation is not the only way to support the decision making process, there are also other existing methods e.g. the multi-criteria assessment, which is capable of taking qualitative information into consideration. Further development of the theoretical background can be implemented in a way to apply extended valuation processes, combining of multi-criteria[2] with the monetary assessment. Land-use change requires an interdisciplinary approach and the collaboration of economic, technological, social and rural alternatives as well and to establish a long-lasting harmonization of the disciplines. The collective application of different kinds of valuation methods results in synergy: both qualitative and quantitative as well as participatory and non participatory information are also available. The variety of methods provide opportunities for cross-checking of opinions and facts as well as important inputs into the multicriteria analysis (O'Connor, 2000). The monetary valuation and MCDA can provide the government and the population with useful information, supporting wetland management and policy.

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[2] The field of Multi Criteria Decision Aid (MCDA) has been developing since the 1960s. Roy was the first pioneer, who developed the Multi-Criteria Assessment with ELECTRE methods (Shmelev et al., 2009) Up to now a lot of techniques have appeared in this field such as PROMETHEE, REGIME or NAIADE. Applications of MCDA are rapidly spreading in the fields of environmental issues.

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Zmiana gospodarowana gruntami jako szansa zmniejszenia konsekwencji ekstremalnych warunków pogodowych: studium przypadku Doliny Cisy na Węgrzech

Streszczenie

Istnieje wiele przyczyn, z powodu których straty powodowane przez ekstremalne warunki pogodowe są na Węgrzech z roku na rok coraz większe. Zaliczyć do nich można uwarunkowania geograficzne Węgier, zmiany klimatyczne, regulacje rzek oraz przekształcanie gruntów na cele uprawne. Zmiany wykorzystania gruntów w ogromnym stopniu przyczyniają się do ubytków w kapitale naturalnym, przede wszystkim zmniejszając powierzchnie terenów podmokłych. Tymczasem są one wielowartościowym zasobem, a jedną z ich funkcji w ekosystemie stanowi regulacja wylewów rzek. Ten rodzaj siedlisk jest w stanie gromadzić nadmiar wody, który z kolei można wykorzystać w trakcie suszy. Jednocześnie odpowiednie gospodarowanie gruntami (np. poprzez zwiększanie powierzchni terenów podmokłych) można stosować w odpowiedzi na ekstremalne warunki pogodowe oraz w celu poprawy kapitału naturalnego. Artykuł przedstawia wyniki badań, ukierunkowanych na określenie społecznego oddziaływania różnych sposobów gospodarowania gruntami za pomocą takich metod badawczych, jak analiza kosztów i korzyści, wycena warunkowa oraz transfer korzyści. Metody te mogą być z powodzeniem stosowane podczas procesów decyzyjnych zrównoważonych środowiskowo, ponieważ są w stanie ukazać społeczne preferencje co do różnych rodzajów siedlisk.

Słowa kluczowe: zmiana gospodarowania gruntami, analiza kosztów i korzyści, usługi terenów podmokłych, metoda wyceny warunkowej, metoda transferu korzyści