BENEFITS OF THE ECOSYSTEMS RESTORATION IN THE DANUBE DELTA – THEORETICAL APPROACH

Anca IONASCU[1], Costel NEGREI[2], Marian TUDOR[3]
[1,3] Danube Delta National Institute for Research and Development, 165 Babadag Street 820112, Tulcea, Romania, email: anca.ionascu@ddni.ro
[2] PhD., Professor, Faculty of Agro-Food and Environmental Economics, The Bucharest University of Economic Studies, 5-7 Mihail Moxa street, Sector 1, Bucharest, Romania, email: costelnegrei@yahoo.com,

Abstract
To identify the benefits of the Danube Delta ecosystem restoration is necessary on the one hand, you know, in a form parameterized, generating mechanism of resources and services, and on the other hand, their importance to potential users. We are stressing that consider a deontological approach, namely that the resources and services provided by Danube Delta ecosystems have a value in itself, considering the system of values, rules governing local, regional and national. A second step of our approach is the selection of methods for evaluating the benefits package, taking into account the characteristics of the project, as reflected by the matrix logic.
Keywords
Benefits, restoration, users, methods, matrix.

Introduction
The ecosystems restoration is a topic that rightfully attracts international attention. All over the world, wetlands are under pressure from economic developments that have lead to a loss of valuable habitat, altered hydrological dynamics and a decline in species diversity. Rapidly increasing populations and growing demands for water and land have led to the degradation of many river systems. Wetlands have important hydrological and biogeochemical functions and provide habitat and food web support for a wide array of organisms. These functions have great value for human society, e.g. in the form of recreational and commercial fishing. Wetlands also contribute to the maintenance of water quality, reduction in global warming and have an important aesthetic value. Ecological restoration may result in a regaining of lost ecological functions, contributing to biological diversity and, in many respects, to human society itself.
Because of its importance for the conservation of global and regional economy, Danube Delta has the opportunity to become a model of sustainable development based on existing ecosystems here.

1. Literature review
Wetlands contribute to the national and local economies by producing resources, enabling recreational activities and providing other benefits, such as pollution control and flood protection. While it can be difficult to calculate the economic value provided by a single wetland, it is possible to evaluate the range of services provided by all wetlands and assign a dollar value. These amounts can be impressive. According to one assessment of natural ecosystems, the dollar value of wetlands worldwide was estimated to be $14.9 trillion. (Source: Constanza et al. 1997). In addition, the economic approach to global ecosystem services is poor, the assessment proposed by Costanza et al. (1997), despite the many criticisms of methodological rigor, is still the most important point of reference.

Based on the Millennium Ecosystem Assessment framework, ecosystem services from wetlands can be categorised into four broad categories. The categories are:

Provisioning services. These are essentially the products obtained wetland ecosystems such as fresh water and fish for human consumption.

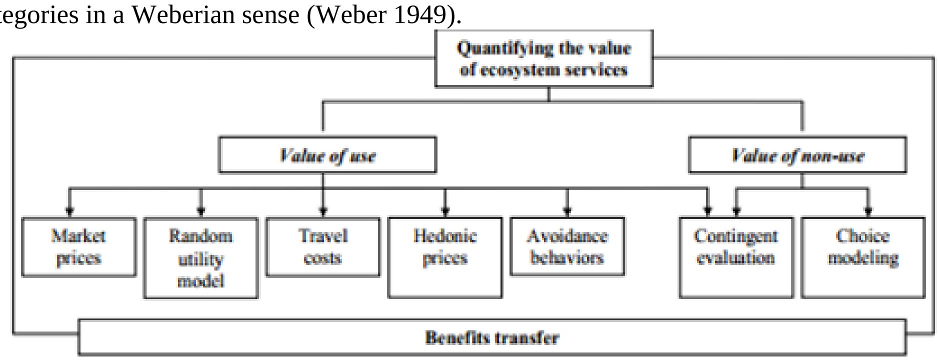
Regulating services. These are essentially the benefits to humans attributable to the regulation of ecosystem processes such as water treatment and local climate regulation.

Supporting services. These services underpin the production of all other ecosystem services such as nutrient cycling, water cycling and provisioning of habitat.

Cultural services. These are typically non-material benefits received by people from direct and indirect interactions with wetlands such as recreation, aesthetic values, spiritual benefits (e.g. Indigenous connections with wetlands) and enhancements in knowledge.

A single wetland may provide multiple types of ecosystem services depending on the particular circumstances of the wetland (type, location, condition, uses etc.). These services are ultimately derived from the ecosystem functions performed by wetlands and the degree to which humans benefit from those functions.

The literature on ecosystem services valuation refers to multiple types of value, including ecological, economic, social, cultural, spiritual, symbolic, therapeutic, insurance and place values. For simplicity and consistency with previous value typologies in the ecosystem services literature (e.g. Farber et al. 2002; Howarth & Farber 2002; Limburg et al. 2002; Wilson & Howarth 2002; de Groot et al. 2002; 2010; Dendoncker et al. 2013; Castro et al. 2014), here we group values addressed in the ecosystem services literature into three broader categories or families: monetary, sociocultural, and ecological values. In practice, the boundaries of these value types are often blurred. For example, the contribution of ecosystems to create employment, for example, may be seen as an economic values as much as a social one. Thus, this value categories should be seen to represent ideal analytical categories in a Weberian sense (Weber 1949).



Source: adaptated after Nijkamp, P., Vindigni, G., Nunes, P.A.L.D. (2008), Economic valuation of biodiversity: A comparative study, Ecological economics, 67

Fig. 1 Quantifying the value of ecosystem services

Monetary valuation of the environment has traditionally conceived ecosystem services that are delivered and consumed in the absence of market transactions as a form of positive externalities that, if valued in monetary terms, can be more explicitly incorporated in decision-making processes (TEEB 2010). In order to capture a more comprehensive picture of the economic value of the environment, the literature on environmental economics identifies different types of monetary values that are generally added up to give the so-called Total Economic Value (e.g. Heal et al. 2005), which be understood as an heuristic displaying the different value dimensions that are of importance for the economic value. The Total Economic Value framework usually divides the economic value of ecosystem services into use and non-use value categories, each subsequently disaggregated into different value components (Pearce and Turner 1990).

The ecosystem services literature has variously defined cultural values as “aesthetic, artistic, educational, spiritual and/or scientific values of ecosystems” (Costanza et al. 1997) or as “non-material benefits people obtain from ecosystems through spiritual enrichment, cognitive development, reflection, recreation, and aesthetic experience” (MA 2005). Cultural values include intangible things such as the place value that emerge from people’s emotional and affective bonds to nature (Altman & Low 1992; Feldman 1990; Williams et al. 1992; Basso 1996; Norton & Hannon 1997; Brown et al. 2002), spiritual value where the conception of nature is intertwined with sacredness (Stokols 1990; Milton 2002), heritage value (Throsby 2001), sense of community (Doolittle & McDonald 1978; Chavis & Pretty 1999), and social cohesion (Lin 2001; Sable & Kling 2001; Doolittle & McDonald 1978; Gómez-Baggethun et al. 2012). All these values are created in the mind of the ecosystem services beneficiaries and therefore the same flow of ecological information may be differently labelled inspirational, educational or spiritual depending on who is the observer.

The literature on environmental valuation has used the notion of ecological value in various contexts and with very different meanings, ranging from monetary values of ecosystems, to biophysical values, to intrinsic values of species, to values associated with ecosystem resilience and stability. In this sense, ecological values can be seen to cover instrumental (i.e., the value that services contribute to sustaining life on Earth and the provision of ecosystem services) as much as intrinsic values (i.e., the value inherent to biodiversity and ecosystems) (Turner et al. 2003). Because the ecosystem service approach has an obvious anthropocentric focus (Jax et al. 2013), whether ecological importance should be seen as a final value (direct input for decision making) or as an intermediate value that ultimately translates into sociocultural and economic values remains an open debate (Gómez-Baggethun 2010; García-Llorene et al. 2011).

2. Methods to quantify the value of ecosystem services

Cost-benefit analysis (CBA) is the most important method of assessment used to support investment projects. This method is based on a variant of Pareto criterion, trying to fi nd ways to assign a monetary value to gains and losses of those affected by the provision of public goods in general, or of particular ecosystem service.

Value of ecosystem services that are not traded in the market can be approximated without being a very accurate measurement possible. This approximation is considered that generally leads to an underestimation of being considered a “dilution” of the value of nature to be preserved, regardless of cost conservation (Kuuluvainen, 2002).

Quantifying ecosystem services is achieved by using a variety of techniques, such as travel costs, hedonic prices, avoidance/replacement costs, contingent evaluation, modeling choice, etc. This is complemented by a range of methods and techniques using secondary data such as transfer of value/benefi ts and meta-analysis techniques. Although, in general, each method is advantageous in a certain context, they developed their typologies. The most common criteria are, at one hand, based on the existence or inexistence of market prices (fig. 2) and, on the other hand, on the way the preferences are expressed.

2.1 Quantifying ecosystem services through methods and techniques based on market mechanisms

Methods and techniques for quantifying ecosystem services based on market mechanisms include: market price method, hedonic price method and travel cost method.

Market Price Method. Market price method is a method which estimates the value of ecosystem services that are bought and sold on the market. The method can be used to assess changes in both the quantity and the quality of a service ecosystem. Using standard economic techniques for measuring the economic benefits of offered services, based on purchased quantities at different prices and on provided quantities at different prices.

Standard method for quantifying the value of use of traded ecosystem service is to estimate consumer surplus and producer surplus using data on prices and quantities. Total net economic benefit is the sum of consumer surplus and producer surplus.

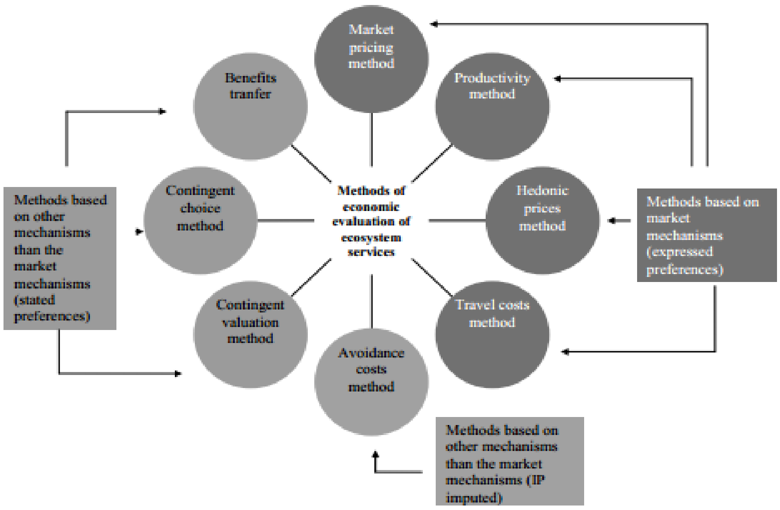


Fig. 2 Classification of methods and techniques for quantifying the economic value of ecosystem services

To estimate the demand function is necessary to estimate the consumer surplus, and data needs include: time series of the amount corresponding to different application rates, data on other factors that affect demand (income or other demographic information). Producer surplus estimation requires data on variable production costs and income received from the good's sale.

If a service ecosystem is input, changing its quantity or quality will lead to changes in the cost of production and/or productivity of other inputs. Further, it will have an effect on price and/or quantity supplied as fi nished goods. It can also affect income per unit of input.

For quantification, there are two major types of benefits (or costs). Thus, if the quality or price changes for the consumer, there will be changes in consumer surplus. If productivity or production cost change, will be changes to producer surplus. Therefore, the economic benefits resulting from improved ecosystem services can be estimated using market data changes.

Method involves collecting data on how changes in the quantity and quality of ecosystem services affect: the cost of production of final goods, supply and demand for the final good, supply and demand for other inputs. This information highlights the changing relationship between quantity and quality of ecosystem services and changes occurring in consumer surplus and/or producer surplus, or economic benefit.

Hedonic Price Method – HPM. Hedonic prices assign a value of ecosystem services by estimating the statistical relationship between system attributes evaluated and another good or service for which a market value exists. The value of the land will be influenced by that of neighboring ecosystems. The analysis aims to assess ecosystem services by quantifying the effect they have on the price of land. This is based on the economic concept that the property value is directly related to the present

value of the stream of benefits derived from property held (Rojanschi et al., 1997).

Travel Cost Method - TCM. Method was proposed in 1947 by Harold Holding for evaluating (estimated value) national parks. It is a method designed to measure in monetary terms the benefi ts obtained by people visiting recreational areas.

The travel cost is considered an approximation of the price that visitors are willing to pay for ecosystem services. Economic assumption is that the demand is even lower as the price is higher. Total benefi t of the resource is given by the area below the demand curve. The total value is, actually, the consumer surplus and its knowledge allows sizing fees for visitors (Rojanschi et al., 2003).

3. The objective of the ecosystems restoration in the Danube Delta

In the Danube Delta Biosphere Reserve there are 30 types of ecosystems, 23 natural and 7 created by man.

The water formations include running waters (danube and its braches, channels with active circulation, channels from natural areas with free waters (Danube and its branches, channels with active circulation, channels from natural areas with free water flow, channels inside polders, with controlled water exchange or no water exchange), fresh still waters (big lakes with/without water exchange, lakes inside polders), still salted or bracksh waters (isolated lakes), coastal lagoons (connected to the sea), marine coastal areas (semi-closed gulfs and marine coastal waters).

The wetlands include aquatic vegetation on the bolders (reedbeds, floating islands, willow formations, meadows on flooded banks associated with willows).

The forests, shrubs and grassy vegetations include temperate river plains (mixt forests of oaks), shrubs, grassy areas (steppe meadows, meadows on marine levees, on fossil loess or calcareous soil), open areas without/with scarce vegetation (dunes, shifting sand dunes with little vegetation, coastal belts, beaches). Anthropic ecosystems include agricultural polders, forestry polders, poplar plantations on river banks, fish farms, ecological restoration areas (abandoned polders).

The objective of ecosystems reconstruction/restoration is to restore the natural, site-specific hydrological, biogeochemical and ecological functions, to ensure the redevelopment of the ecosystem and its functions and thus to promote the development of site-specific habitats and their biodiversity. Moreover, the redevelopment of the natural resources should enable the local populations to proceed to their sustainable, traditional use.

Given that the ecosystems of the Danube Delta depend on the dynamics of the Danube River, the re-establishment of the hydrological regime reveals to be the most important factor to be considered in restoration (Marin et. al. 1997, Schneider 2002).

Restored natural functions allow the redevelopment of natural resources and values that are to the benefit of the local populations and of major importance for the local, regional and national economy. Given their natural functions and values that are traditionally used with regard to sustainability, the restored wetlands also satisfy fundamental socio-economic functions. For the local populations of the Delta the restoration of abandoned agricultural polders and fish ponds is a good option as compared to the abandoned polders that could not be used as planned.

Both the retention area of Babina island which has been reconnected to the dynamics of the Danube River and the Cernovca area play an important biogeochemical role for nutrient retention and cycling. The reed beds dispose of perfect nitrogen filter qualities. For Babina and Cernovca islands the retention of nitrogen N amounts to a total value of 355.6 t N/year on a reed area covering a total surface of 2435.312 ha. Phosphorus arrives in the area with the spring floods and is retained in the reedbeds. In summer time this phosphorus allows the growth of phytoplankton and macrophytes.

Table 1 Benefits of ecological restoration. Babina & Cernovca pilot projects (S=3600 ha)

<table>
<tr><th colspan="2">Economical results</th><th colspan="2">Ecological results</th></tr>
<tr><td>Fish</td><td>34 kg/ha/year</td><td>Nutrient removal</td><td>-15 kg P/ha/year
- 335 kg N/ha/year</td></tr>
<tr><td>Reed</td><td>1-2 tones/ha/year</td><td>Sediment retention</td><td>11 tones/ha/year</td></tr>
<tr><td rowspan="3">Pasture</td><td rowspan="3">0,5 UVM/ha/year</td><td>Habitat for birds and fishes</td><td rowspan="3"></td></tr>
<tr><td>Aethetic values</td></tr>
<tr><td>Water storage</td></tr>
</table>

Table 2 Economical indicator:
maximum cost/benefit ratio Babina & Cernovca pilot projects (S=3600 ha)

Costs:		
Research, Design & Implementation: 100 000 Euro		
Benefits:		
Fish yield	3600 ha x 34 kg/ha x 0,5 Euro/kg	= 60 000 Euro/year
Reed harvest	3600 ha x 1t/ha x 16Euro/t	= 60 000 Euro/year
Tourism	10 tourists x 100days/year x 10 Euro/day	= 10 000 Euro/year
Cattle	100 ha x 0,5UVM/ha x 100 kg x 2 Euro/kg	= 10 000 Euro/year
TOTAL VALUE: 140 000 Euro/year at low labour costs		

The ecological effects observed after the restoration measures have been completed are new habitats for plants and animals, broader spawning grounds for fish as well as extended habitats for aquatic birds, hydrological dynamics and water storage, sediment retention, fixing of toxic sub stances and an important function as biofilter for the Black Sea. All these effects have generated remarkable economic benefits. They result in considerable amounts of fish, reed, medicinal plants and interesting aquatic landscapes for tourists.

Restored natural functions allow the redevelopment of natural resources and values that are to the benefit of the local populations and of major importance for the local, regional and national economy. Given their natural functions and values that are traditionally used with regard to sustainability, the restored wetlands also satisfy fundamental socio-economic functions. For the local populations of the Delta the restoration of abandoned agricultural polders and fish ponds is a good option as compared to the abandoned polders that could not be used as planned.
Marsh vegetation and moist grasslands have rapidly redeveloped. Plants with a high seed potential as well as still existing rootstocks of plants in the soil and rapidly growing species that spread by means of stolons efficiently covered broad areas. Especially the surface-covering reeds quickly redeveloped stable stands and represent a major useable resource to the local population.

Conclusions

Quantifying ecosystem services focused the attention of numerous researchers, and its correlation with the development of meta-analytic techniques allows increasing the transferability of results and coverage of evaluations. Accelerate this process depends on the available resources for conducting empirical studies, but also by improving knowledge interactions at the level of ecosystems, and between them and society, to create landmarks improvement methodologies in increasing the validity and reliability of results.
Ecological restoration has a significant potential for economic development and bring benefits to local communities, both for landowners and for entrepreneurs in the area such as tourism, fishing and small businesses based on local products.
Applicability methods evaluated is difficult if the services provided mostly as an expression of the function of regulation and control.

References

1. Castro, A., García-Llorente, M., Martín-López, B., Palomo, I., Iniesta-Arandia, I., 2014: Multidimensional approaches in ecosystem service assessment. In: Alcaraz-Segura, D., Di Bella, C. D., Straschnoy, J. V. (eds.): Earth Observation of Ecosystem Services, CRC Press, Boca Raton, pp. 427-454.
2. Costanza, R., R. d'Arge, R. de Groot, S. Faber, M. Grasso, B. Hannon, K. Limburg, S. Naeem, R. O'Neill, J. Paruelo, R. Raskin, P. Sutton and M. van den Belt 1997, 'The value of the world's ecosystems and natural capital', *Nature*, 387, 253-260.
3. de Groot, R.S., M. A. Wilson and R.M.J Boumans 2002, ”A typology for the classification, description and valuation of ecosystem functions, goods and services”, *Ecological Economics*, 41 (3), 393-408.
4. Farber, S.C., R. Costanza and M. A Wilson 2002, 'Economic and ecological concepts for valuing ecosystem services', *Ecological Economics*, 41 (3), 375-392.
5. Freeman, A.M. III. 2003. The Measurement of Environmental and Resource Values, Theory and Methods. Resources for the Future.
6. García-Llorente, M., B. Martín-López, S. Díaz, C. Montes 2011, ”Can ecosystem properties be fully translated into service values? An economic valuation of aquatic plants services”, *Ecological Applications*, 21, 3083-3103.

7. Gómez-Baggethun, E. 2010. To ecologise economics or to economise ecology: Theoretical controversies and operational challenges in ecosystem services valuation. *Thesis (PhD)*, Universidad Autónoma de Madrid, Madrid, Spain.
8. Howarth, R. and S. Farber 2002, ”Accounting for the value of ecosystem services”, *Ecological Economics*, 41 (3), 421-429.
9. Jax, K., D. Barton, K. Chan, R. de Groot, U. Doyle, U. Eser, C. Görg, E. Gómez-Baggethun, Y. Griewald, W. Haber, R. Haines-Young, U. Heink, T. Jahn, H. Joosten, L. Kerschbaumer, H. Korn, G. Luck, B. Matzdorf, B. Muraca, C. Neßhöver, B. Norton, K. Ott, M. Potschin, F. Rauschmayer, C. von Haaren and S. Wichmann 2013, ‘Ecosystem services and ethics’, *Ecological Economics,* 93, 260-268.
10. Kuukuvainen, J. 2002, Value of nature conservation: the good or the context, *Journal of Forest Economics*, 8.
11. Marin, G. & E. Schneider 1997: *Ecological restoration in the Danube Delta Biosphere Reserve/ Romania. Babina and Cernovca islands*, Ed. INCPDD & WWF Auen- Institut, pp. 120.
12. Pearce, D.W. and R. Turner 1990, *Economics of Natural Resources and the Environment*, Baltimore, USA: John Hopkins University Press.
13. Rojanschi, V., Bran, F., Diaconu, G., Iosif, G.N., Toderoiu, F. 1997, *Economia şi protecţia mediului*, Editura Tribuna economică, Bucureşti.
14. Rojanschi, V., Bran, F., Grigore, F., Diaconu, S. 2003, *Abordări economice în protecţia mediului*, Editura ASE, Bucureşti.
15. Schneider E. 2002, The ecological functions of the Danubian floodplains and their restoration with special regard to the Lower Danube- Large Rivers, 13, *1-2 Arch Hydrobiol*, Suppl 141, 1-2: 129-149.
16. Millennium Ecosystem Assessment 2003. *Ecosystems and human well-being: A framework for assessment.* Island Press, Washington DC.
17. Nijkamp, P. Vindigni, G., Nunes, P.A.L.D. 2008, Economic valuation of biodiversity: A comparative study, *Ecological economics*, 67.
18. TEEB-The Economics of Ecosystems and Biodiversity 2010, *The Economics of Ecosystems and Biodiversity: Ecological and Economic Foundations*, P. Kumar (ed.), London, UK: Earthscan.
19. Turner, K.R., J. Paavola, P. Cooper, S. Farber, V. Jessamy and S. Georgiou 2003, ”Valuing nature: Lessons learned and future directions”, *Ecological Economics*, 46, 493-510.
20. Weber, M. 1949. The methodology of the social sciences New York: Free Press.
21. Wilson, M.A. and R. Howarth 2002, ”Discourse-based valuation of ecosystem services: establishing fair outcomes through group deliberation”, *Ecological Economics*, 41(3), 431-443.