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EVALUATION OF THE ECOSYSTEM SERVICES OF INLAND WATERS IN THE SLOVAK REPUBLIC – TO DATE FINDINGS

RADOSLAV BUJNOVSKÝ

Water Research Institute, Nábr. arm. gen. L. Svobodu 5, 812 49 Bratislava, Slovak Republic; e-mail: bujnovsky@vuvh.sk

Abstract

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Ecosystem services (ES) (goods and services) represent the outputs of natural systems from which people can have benefits. Evaluation of the benefits resulting from ES of inland waters or the benefits, which are lost when the necessary measures are not implemented, is one of the methods of evaluating the external costs of environmental damage – environmental and resource costs. Evaluation of ES is based on the CICES classification v. 4.3, which defines provision, regulation/maintenance and cultural services. In the assessment of ES also enters groundwater, although in comparison with surface waters in lesser extent. At present, the evaluation is performed at the level of sub-basins of the Slovak Republic. In this paper, evaluation of selected ES is presented. Use of evaluation in practice is also discussed.

Key words: inland waters, ecosystem services; benefits.

Introduction

Ecosystem services (ES) are the result of biophysical structures and processes of both natural and anthropogenically modified environment, and represent the output of relevant ecosystems, of which people may have benefits (e.g. Millennium Ecosystem Assessment, 2005; Boyd, Banzhaf, 2007; Fisher, Turner, 2008). The value of these benefits can have so utility and non-utility, as well as material and intangible character.

Improving of management and avoiding overexploitation of natural resources, together with finding of ES values, belong to the objectives of the renewed EU Strategy for Sustainable Development. Evaluation of ES is also enshrined in the EU Biodiversity Strategy to 2020 and further also in updated National Biodiversity Strategy to 2020 in the Slovak Republic. Evaluation of benefits resulting from the inland waters ES or benefits, which are lost when necessary measures are not implemented, is one of the ways for estimation of external costs of environmental damage – environmental costs and resource costs what follows from Article 9 of the Water Framework Directive (Brouwer, 2004). Evaluation of benefits in ensuring ES of inland waters and their changes is usually confronted with the change in the value expressing the human welfare.

Definition of ES and basic principles of their assessment

Achievement of objectives 2 and 4 of the EU Biodiversity Strategy to 2020 and targets B.3 C.6 of Updated National Biodiversity Strategy to 2020 in the water area to some extent corresponds with evaluation of ES linked to inland waters, i.e. rivers and lakes, as one of the main categories of ecosystems defined by Maes et al. (2013).

As reported by Austin et al. (2012), there are two aspects of the evaluation of ES, namely the supply and demand, which together determine their value. In the following text, the attention is primarily focused on demand side, which indicates the extent the use of ES at present.

The starting point for evaluation the ES of inland waters is an international classification CICES v. 4.3 (Haynes-Young, Potschin, 2013), which in fact embraces the goods, services and cultural benefits (Barbier, 2007). Both surface and ground waters enter in the evaluation of ES. The selection of significant ES in Slovak conditions corresponds with the prior assessment of the benefits resulting from inland waters and aquatic ecosystems at the global level (DeGroot et al., 2012) with a focus on utility values (Table 1).

A number of ES (in particular the provision of raw water for different types of use, regulation of water quality and recreational activities) directly relate to the provision of main water services, which were analyzed in the Water Plan of the Slovak Republic (MoE, 2010). It is necessary to mention that the extent of the ES assessment of inland waters is primarily influenced by the availability and quality of bio-physical data that enter the subsequent economic valuation.

Ecological status of waters is often considered as an expression the quality of the structure and function(s) (and consequently services/services) of aquatic ecosystems that are bound to surface water. This fact has a relative validity, because some services of water and aquatic ecosystems are not tied to the achievement of good ecological (and chemical) status, e.g. waterway transport, exploitation of hydropower potential or use of water for cooling in industry. In addition, some types of water use have designed specific qualitative objectives (surface water for drinking purposes, water for crop irrigation, water suitable for life and reproduction of indigenous species and natural bathing waters). So, suitability for use of water for a specific purpose, which represents the concrete ecosystem service, is assessed with the assumption that water quality is harmony with particular set of water quality parameters and corresponding limit values.

As the application of the results obtained through recommended preferential methods is often problematic (Chee, 2004; Brouwer, 2008; Seják et al., 2010), that fact is the reason for the application of the cost methods, although not always sufficiently reflect the total economic value. At the economic assessment of inland waters ES in the Slovak Republic are used primarily non-preferential methods (in particular, the methods of market valuation and cost based methods), which are useful in the case of evaluation of provision and regulatory services (COWI, 2014; Rohani, 2013).

With regard to the differences in spectral classification schemes for assessing the quality of individual water uses on the one hand, and good ecological and chemical status of waters on the other hand, the evaluation of the benefits or deficits arising from achieving or non-achieving of good status of water becomes problematic. This finding is confirmed by number of authors (e.g. Viscusi et al., 2008; Kroiss, 2014).

T a b l e 1. Significant ES of inland waters and related benefits from their provision in Slovak conditions.

Ecosystem services		Benefits from ES
Surface water		
Provisional	Biomass	Water animals – namely fishes
	Raw water	Water for drinking purposes Water for crop irrigation Water as raw material in industry Water as cooling medium in industry
	Materials (the consequence of substances accumulation)	Gravel, sands (riverbed sediments)
	Renewable energy	Electricity production
Regulation and maintenance	Regulation of water quality	Degradation of pollutants
	Transport medium	Waterway transport
	Habitat preservation, gene reserve	Creation of conditions for aquatic (and water influenced) biotopes
Cultural	Physical or experiential use of ecosystems	Recreational activities (recreational fishing, bathing, water tourism)
Groundwater		
Provisional	Raw water	Water for drinking purposes Water for crop irrigation Water as raw material in industry Water as cooling medium in industry
	Renewable energy	Source of geothermal energy
Regulation and maintenance	Habitat preservation, gene reserve	Creation of conditions for water influenced (especially terrestrial) biotopes
Cultural	Physical or experiential use of ecosystems	Recreational activities on exposed groundwater

Evaluation of some ES of inland waters – principles and results

Increase of crop yield through use of *irrigation water* can be considered as the actual effect of the use of ES, which depends on the availability of irrigation systems, the structure of crops and, finally, the economic prosperity of farms. In general, it can be stated that the potential of water use for irrigation is higher than recorded water consumption for this purpose in recent years. The actual abstractions in different years for Slovakia, which states Hydromeliorácie s.e. (State Enterprice), were divided into sub-basins according to registration of Slovak Hydrometeorological Institute. Like that, estimated amount of produced dry matter is related to the production of early potatoes (as representative crop) and an average price of this commodity in the years 2011–2013. The final price is reduced by costs for rental costs of irrigation-operating units. The average annual benefits from the use of ES in period 2011–2013 represents approximately 25,741 thousand €, of which the share relating to surface water is 22,160 thousand €. Subsequent deducting of costs for water pumping reduces this benefit.

The use of *recreational fishing* ES is tied to fishing grounds. In the context of surface and ground water in Slovakia are currently defined more than 1000 fishing grounds. The benefit from recreational fishing is most often expressed by appreciation of amount/weight of individual fish species. It corresponds well with the recommendations in COWI document (COWI, 2014), in which it is simultaneously stated that this estimate may underestimate or overestimate the real situation. Due to the fact that fish stocks are in fishing grounds in Slovakia usually purposefully influenced (stocking and feeding of fish), information regarding the benefits from the use of ES in term of catch are distorted (fish stocks significantly affects the amount of catch) and do not give in this respect realistic picture about the potential of the natural environment. In the case of recreational fishing within the fishing grounds, resulting value of the catch affect fish stocks, the number of visitors, as well as any change of the price list of fish ŠRZ-Council Žilina used for valuation the catch of individual species. The value of such benefit, calculated for 2012, is 7,910 thousand €, of which the share relating to surface water is 5,996 thousand €. Similar benefit is expected for previous (2011) and subsequent (2013) year.

In Slovakia, some *natural water areas* (water reservoirs and exposed groundwater) are used *for swimming and recreation*. Bathing waters specified by national legislation (Act No. 355/2007 Coll.) represent the most significant waters that are used by large numbers of bathers and for which has not been issued a permanent bathing prohibition or permanent advice against bathing. Benefit from the use of this type of ES is typically assessed through travel costs method or derived from visitor incomes to recreational sites (factor income of the area of recreation). Fees for the use of natural swimming pools (entrance fee) represent another way to estimate the benefits (market valuation method). It should be noted, however, that the crucial item of the entrance fee (in the case so called 'operated natural pools') are services provided by the operator. In the case of remaining natural bathing waters, approved by above mentioned legislation, we can consider only a rough estimate of the potential fees, because access and subsequent use is free. One alternative for recreationists, in the absence of natural waters for swimming, is the use of artificial pools which need to be built for this purpose, while bathing water (except for the thermal pools) is usually taken from the public water supply systems. Cost savings for water and sewerage (avoided costs method) in principle represent the immediate benefits of the use of natural waters. The value such benefit related to annual value for the period 2011–2013 is 1,155 thousand €, of which the share relating to surface water represents the 665 thousand €.

As can be seen from the preceding text, result of the evaluation is significantly influenced by the way the assessment or parameters entering into the evaluation. For example, in the case of water for irrigation the result is significantly influenced by the consumption of irrigation water in relation to the weather course and the inter-annual commodity price, used to express the effect of irrigation. In the case of recreational swimming in natural waters for bathing the economic effect of the ES is derived from the number of visitors within the bathing season which directly influences the weather course.

The application of evaluation results of water services and water ecosystems from the perspective of Water Framework Directive

In the context of documents focused on protecting biodiversity (EU Strategy on Biodiversity in 2020 and updated National Biodiversity Strategy to 2020), mapping and assessment of ecosystems is considered as the basic starting point for the conservation and enhancement of ecosystems and their services, especially using information obtained in the strategy and policy documents. Protection of aquatic ecosystems consequently results from the implementation of measures under the WFD.

The original intention of Water Framework Directive (WFD) is primarily to protect and improve the state of the aquatic environment in terms of social benefits but the term 'ecosystem services' in the WFD is not used. The authors Vlachopoulou et al. (2014) perceive the assessment of ES as part of or supplement in achieving the objectives of the WFD. As introduced in COWI document (COWI, 2014), integration of ES assessment into the planning process at the basin level can be either complete or partial. While full integration includes mapping of all ES through an ecosystem approach, partial integration is the consideration of ES as the support of implementation of the directives. Use of ES assessment finds application in (i) potential application of derogations under Article 4 of the WFD, (ii) identifying and selecting cost-effective measures in the program of measures (Article. 11 WFD) and (iii) at designing of measures beyond legislative requirements and limits within payments for ES (measures do not always directly regulate the use of the services of aquatic ecosystems).

Specific objectives of WFD as 'good condition' and 'non-deterioration' directly do not describe benefits that population can directly feel or experience. Reflection of these objectives in to ES, from which population has benefits, can improve the involvement of stakeholders in the implementation process (Everard, 2012; COWI, 2014).

Discussion

As follows from the evaluation of the economic evaluation of benefits from the use of inland water ecosystems at the global level (DeGroot et al., 2012), a decisive share is accounted for the provision of water used for different purposes (42%) and recreational activities linked to water (51%). Morris, Camino (2011) evaluated ES of three types of ecosystems – (i) rivers and lakes, (ii) wetlands and (iii) floodplains. In the context of the evaluation, rivers and lakes are seen as an important source of water for different types of use.

Economic valuation seems an adequate framework for improvement of decisions related to sustainable use of natural resources (NRC, 2005) although such valuation, opened for next improvement, has some limitations (e.g. Sales, 2011; Waigner, Mazzotta, 2011; Wallis et al., 2011). With regard to WFD, Wallis et al. (2011) state that an ES approach helps the prioritisation of financial resources for integrated water management programmes. As mentioned in COWI document (COWI, 2014), ecosystem-based approach can be used in the implementation of the WFD and Flood Directive.

The ES framework is considered as an approach that can be helpful at best management and allocating natural resources taking into account competing interests (Faber et al., 2006; Waigner et al., 2010). As reported Landsberg et al. (2011), ES approach can improve the process of environmental and social impact assessment (ESIA). In addition, assessment and valuation of ecosystems and their changes is seen as the starting point for the change of attitude of individuals and societies to natural resources (POST, 2011). On the other hand Norgaard (2010) highlights the problems of real application of ecosystem service approach due to ecological, economic and political complexities of the challenges which humanity actually face. Gómez-Baggethun and Ruiz-Pérez (2011) pointed out that charging for ES (related to market expansion into formerly non-market areas) to create the conditions for it to become the subject of ES trade. Ecosystem functions are thus included into the system of valuation and market relations, which creates a real risk to the protection of ecosystems.

It is necessary to stress that objectivity, scope and detail of the assessment ES of inland waters depends on the availability and quality of bio-physical data. As the ES assessment is not or may not be in direct relation to the achievement of the environmental objectives of the WFD, capacity for providing of more ES often depends on factors other than water quality. This means that improving water status by achieving good ecological and chemical status can result only in increasing the capacity of some ecological functions.

References

Austin, D., Cerman, G., Heywood, T., Marshall, R., Refling, K. & Van Patter L. (2012). *Valuing natural capital and ecosystem services*. Ontario: University of Guelph.

Barbier, E.B. (2007). Valuing ecosystem services as productive inputs. *Economic Policy*, 22, 177–229. DOI: 10.1111/j.1468-0327.2007.00174.x.

Boyd, J. & Banzhaf S. (2007). What are ecosystem services? The need for standardized environmental accounting units. *Ecological Economics*, 63(2–3), 616–626. DOI: 10.1016/j.ecolecon.2007.01.002.

Brouwer, R. (2004). The concept of environmental and resource costs. Lessons learned from ECO2. In R. Brouwer & P. Strosser (Eds.), *Environmental and resource costs and the Water Framework Directive. An overview of European practices* (pp. 3–12). Workshop Proc. RIZA, Lelystad.

Brouwer, R. (2008). The potential role of stated preference methods in the water framework directive to assess disproportionate costs. *Journal of Environmental Planning and Management*, 51(5), 597–614. DOI: 10.1080/09640560802207860.

Chee, Y.E. (2004). An ecological perspective on the valuation of ecosystem services. *Biol. Conserv.*, 120, 549–565. DOI: 10.1016/j.biocon.2004.03.028.

COWI (2014). *Support policy development for integration of an ecosystem services approach with WFD and FD implementation*. Towards practical guidelines to support River Basin Planners. Kongens Lyngby: COWI A/S.

DeGroot, R., Brander, L., Van der Ploeg, S., Constanza, R., Bernard, F., Braat, L., Christie, M., Crossman, N., Ghermandi, A., Hein, L., Hussain, S., Kumar, P., McVittie, A., Portela, R., Rodriguez, L.C., ten Brink, P. & Van Beukering P. (2012). Global estimates of the value of ecosystems and their services. *Ecosystem Services*, 1, 50–61. DOI: 10.1016/j.ecoser.2012.07.005.

Everard, M. (2012). Why does „good ecological status" matter? *Water and Environment Journal*, 26, 165–174. DOI: 10.1111/j.1747-6593.2011.00273.x.

Farber, S., Constanza, R., Childers, D.L., Erickson, J., Gross, K., Grove, M., Hopkinson, Ch.S., Kahn, J., Pincetl, S., Troy, A., Warren, P. & Wilson M. (2006). Linking ecology and economics for ecosystem management. *Bioscience,* 56(2), 121–133. DOI: 10.1641/0006-3568(2006)056[0121:LEAEFE]2.0.CO;2.

Fisher, B. & Turner R.K. (2008). Ecosystem services: classification for valuation. *Biol. Conserv.*, 141(5), 1167–1169. DOI: 10.1016/j.biocon.2008.02.019.

Gómez-Baggethun, E. & Ruiz-Pérez M. (2011). Economic valuation and the commodification of ecosystem services. *Progress in Physical Geography*, 35, 613–628. DOI: 10.1177/0309133311421708.

Haines-Young, R. & Potschin M. (2013). *CICES V4.3 - Revised report prepared following consultation on CICES Version 4. EEA Framework Contract No EEA/IEA/09/003*. University of Nottingham: Centre for Environmental Management.

Kroiss, H. (2014). A quest for quality. *Water*, 21, 12–13.

Landdsberg, F., Ozment, S., Stickler, M., Henninger, N., Treweek, J., Venn, O. & Mock G. (2011). *Ecosystem services review for impact assessment. Introduction and guide to scoping*. WRI Working Paper. Washington D.C. : World Resources Institute.

Maes, J., Teller, A., Erhard, M., Liquete, C., Braat, L., Berry, P., Egoh, B., Puydarrieux, P., Fiorina, C., Santos, F., Paracchini, M.L., Keune, H., Wittmer, H., Hauck, J., Fiala, I., Verburg, P.H., Condé, S., Schägner, J.P., San Miguel, J., Estreguil, C., Ostermann, O., Barredo, J.I., Pereira, H.M., Stott, A., Laporte, V., Meiner, A., Olah, B., Royo Gelabert, E., Spyropoulou, R., Petersen, J.E., Maguire, C., Zal, N., Achilleos, E., Rubin, A., Ledoux, L., Brown, C., Raes, C., Jacobs, S., Vandewalle, M., Connor, D. & Bidoglio G. (2013). *Mapping and assessment of ecosystems and their services. An analytical framework for ecosystem assessments under action 5 of the EU biodiversity strategy to 2020*. Luxembourg: Publications Office of the European Union.

Millennium Ecosystem Assessment (2005). *Ecosystems and human well-being: synthesis*. Washington, DC: Island Press.

MoE (Ministry of Environment) (2010). *Water plan of the Slovak Republic*. Abbreviated version. Banská Bystrica: SAŽP.

Morris, J. & Camino M. (2011). *Economic assessment of freshwater, wetland and floodplain (FWF) ecosystem services*. UK NEA Economics analysis report. Bedford: School of Applied Sciences, Ceanfield University.

NRC (National Research Council) (2005). *Valuing ecosystem services*. Toward better environmental decision-making. Washington, D.C.: The National Academic Press.

Norgaard, R.B. (2010). Ecosystem services: From eye-opening metaphor to complexity blinder. *Ecological Economics*, 69, 1219–1227. DOI: 10.1016/j.ecolecon.2009.11.009.

POST (2011). Living with environmental limits. *Postnote*, 370, 4.

Rohani, M. (2013). *Freshwater values framework*. A review of water valuation methods utilized within total economic valuation. Auckland Council working report WR2013/001. Auckland: Auckland Council.

Salles, J.M. (2011). Valuing biodiversity and ecosystem services: Why put economic values on nature? *C. R. Biol*., 334, 469–482. DOI: 10.1016/j.crvi.2011.03.008.

Seják, J., Pokorný, J. & Cudlín P. (2010). Možnosti hodnocení ekosystémových služeb. *Životné Prostredie*, 44(2), 74–77.

Viscusi, W.K., Huber, J. & Bell J. (2008). The economic value of water quality. *Environmental and Resource Economics*, 41, 169–187. DOI: 10.1007/s10640-007-9186-4.

Vlachopoulou, M., Coughlin, D., Forrow, D., Kirk, S., Logan, P. & Voulvoulis N. (2014): The potential of using the ecosystem approach in the implementation of the EU Water Framework Directive. *Sci. Total Environ*., 470–471, 684–694. DOI: 10.1016/j.scitotenv.2013.09.072.

Waigner, L.A., King, D.M., Mack, R.N., Price, E.W. & Maslin T. (2010). Can the concept of ecosystem services be practically applied to improve natural resource management decisions? *Ecological Economics*, 69, 978–987. DOI: 10.1016/j.ecolecon.2009.12.011.

Waigner, L. & Mazzotta M. (2011). Realizing the potential of ecosystem services: A framework for relating ecological changes to economic benefits. *Environ. Manag*., 48, 710–733. DOI: 10.1007/s00267-011-9726-0.

Wallis, C., Séon-Massin, N., Martini, F. & Schouppe M. (2011). *Implementation of the Water Framework Directive when ecosystem services come into play*. 2nd "Water Science Meets Policy" event. Brussels, 29-30th September 2011.