Science of the Total Environment xxx (2015) xxx–xxx

Contents lists available at ScienceDirect

Science of the Total Environment

journal homepage: www.elsevier.com/locate/scitotenv

Development of an integrated methodology for the sustainable environmental and socio-economic management of river ecosystems

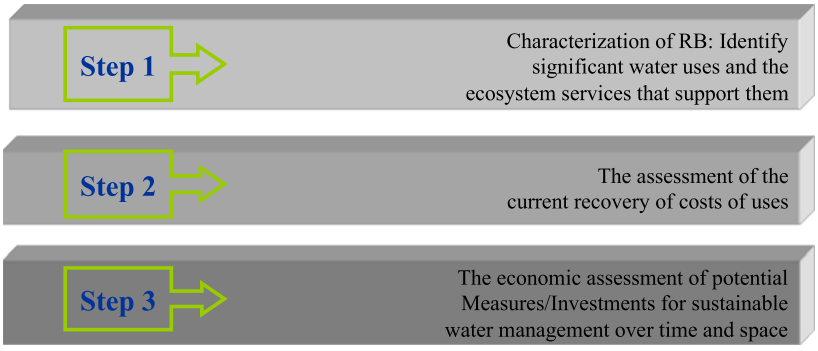
P. Koundouri [a,b,c,*], P. Ker Rault [d], V. Pergamalis [c], V. Skianis [c], I. Souliotis [a,c]

[a] Athens University of Economics and Business, Greece
[b] London School of Economics, UK
[c] International Centre for Researcher on the Environment and the Economy (ICRE8), Greece
[d] Alterra Wageningen University & Research, Netherlands

HIGHLIGHTS

- Total Economic Value integrating the Ecosystem Services Approach
- Economic valuation techniques
- Empirical results — value transfer technique

GRAPHICAL ABSTRACT



ARTICLE INFO

Article history:
Received 30 April 2015
Received in revised form 26 June 2015
Accepted 17 July 2015
Available online xxxx

Editor: D. Barcelo

Keywords:
Sustainable river management
Total Economic Value
Ecosystem Services Approach
Integrated methodology, WFD
Value transfer method

ABSTRACT

The development of the Water Framework Directive aimed to establish an integrated framework of water management at European level. This framework revolves around inland surface waters, transitional waters, coastal waters and ground waters. In the process of achieving the environment and ecological objectives set from the Directive, the role of economics is put in the core of the water management. An important feature of the Directive is the recovery of total economic cost of water services by all users. The total cost of water services can be disaggregated into environmental, financial and resource costs. Another important aspect of the directive is the identification of major drivers and pressures in each River Basin District. We describe a methodology that is aiming to achieve sustainable and environmental and socioeconomic management of freshwater ecosystem services. The Ecosystem Services Approach is in the core of the suggested methodology for the implementation of a more sustainable and efficient water management. This approach consists of the following three steps: (i) socio-economic characterization of the River Basin area, (ii) assessment of the current recovery of water use cost, and (iii) identification and suggestion of appropriate programs of measures for sustainable water management over space and time. This methodology is consistent with a) the economic principles adopted explicitly by the Water Framework Directive (WFD), b) the three-step WFD implementation approach adopted in the WATECO document, c) the Ecosystem Services Approach to valuing freshwater goods and services to humans. Furthermore, we analyze how the effects of multiple stressors and socio-economic development can be quantified in the context of freshwater resources management. We also attempt to estimate the value of four ecosystem services using the benefit transfer approach for the Anglian River Basin, which showed the significance of such services.

* Corresponding author at: Athens University of Economics and Business, Greece.
E-mail addresses: pkoundouri@aueb.gr, phoebe.koundouri@icre8.eu (P. Koundouri).

http://dx.doi.org/10.1016/j.scitotenv.2015.07.082
0048-9697/

1. Introduction

Undoubtedly, water is one of the most valuable resources for the survival of species and the functioning of the natural environment. It is easy to understand that its qualitative and quantitative statuses play a crucial role in human health, but also in the socio-economic development in Europe. While water can contribute to economic development, the latter can pose a significant threat on water resources, if there is no control over effluents release and the extraction of the resource. Economists have long been fascinated by the complexity embedded in managing water resources (see for example, Booker et al., 2012; Easter and Renwick, 2004; Koundouri, 2004). This complexity dwells from the non-market characteristics of the water resources. Non-excludability, which means inability to deprive individuals from the enjoyment of yielded benefits and no jointness in consumption, reinforces individuals to conceal their preferences in relation to natural resources. For this reason, the market mechanism cannot yield the optimal allocation of costs and benefits accruing from the use of environmental resources. Benefits that stem from them, as will be described below, relate to the use and non-use values generated by environmental goods. Undoubtedly, such values can be directly linked to the ecosystem services provided by the natural resources. Therefore, recent advancements in the literature suggest the incorporation of the Ecosystem Services Approach (De Groot et al., 2002) into the management of water resources.

This paper describes a methodology that is being followed in order to achieve sustainable environmental and socioeconomic management of freshwater ecosystem services. This approach is consistent with a) the economic principles adopted explicitly by the Water Framework Directive (WFD), b) the three-step WFD implementation approach adopted in the WATECO document, c) the Ecosystem Service Approach to valuing freshwater goods and services to humans (Martin-Ortega et al., 2015). This paper starts with the economic aspects and implementation of WFD, continues with the description of Ecosystem Services Approach and ends with the description of the steps and sub-steps of the proposed methodology. Furthermore, in order to illustrate its implementation, the paper presents values of ecosystem services in Anglian river basin estimated with the use of the benefit transfer method. In this way, we describe how the arsenal of economic techniques can be used to monetize ecosystem benefits. Overall, the methodology attempts to connect the biological, economic and social aspects of water bodies for achieving sustainable management of water resources.

2. Economic aspects of the water framework directive

The development of the Water Framework Directive aimed to establish an integrated framework of water management at European level. This framework revolves around inland surface water, transitional water, coastal water and ground water. The integrated nature of the directive pursues a holistic approach of these various types of water resources. In this regard, the management engages in both qualitative and quantitative aspects of water in order to achieve good water status for EU waters by 2015 (EC, 2000).

In the process of achieving the environment and ecological objectives set from the Directive, the role of economics is put in the core of the water management. More specifically, the WFD requires the application of economic principles, approaches and instruments at River Basin District level. Article 5 "Characteristics of the river basin district, review of environmental impact of human activity and economic analysis of water use," Article 9 "Recovery of costs for water services," Article 11 "Program of measures" and Annex III "Economic analysis", discuss those economics elements. The management takes place at River Basin District level. In harmony with the WFD, each River Basin management plan has to undertake specific steps.

The first step is to conduct the economic characterization of water at River Basin District level. This involves the estimation of the socio-economic significance of water uses and the investigation of the dynamics of key economic drivers that may influence water pressures and its current status. The second step is an assessment of the recovery of the costs of water services, and the final step is an economic assessment of potential measures for balancing water demand and supply (WATECO, 2002).

An important feature of the Directive is the recovery of total economic cost of water services by all users of water resources. According to Article 9, the Member states "shall take account of the principle of recovery of the costs of water services, including environmental and resource costs, having regard to the economic analysis conducted according to Annex III, and in accordance, in particular, with the polluter pays principle" (EC 2000:12). The total cost of water services can be disaggregated into environmental, financial and resource costs (see Table 1).

The environmental cost is associated with social welfare losses that are caused by the deterioration of water quality. The financial cost includes the costs of providing and managing water services, which are related to the operations of water suppliers. The resource cost relates to the additional costs that have to be bore in order for the water demand to be covered due to overextraction of the available quantity of water resources, or the reduction in water supply due to weather conditions. For the purposes of the WF Directive, the cost recovery of water services should be linked to different water uses for different sectors, such as households, industry and agriculture.

Another important aspect of the WFD is the identification of major drivers and pressures in each River Basin District. Information on these should be included in the economic analyses as underlined by Annex III. Additionally, according to the polluters pay principle, the contribution of water uses in the recovery of cost should also be contained in the economic analyses, in order to assist in the identification of appropriate measures based on their cost-effectiveness (EC 2000:31).

Finally, Article 9 of the WFD calls for introduction of pricing policies and other economic instruments that incorporate an element of cost recovery related to environmental benefits.

3. Description of the Ecosystem Services Approach

As already mentioned, the Ecosystem Services Approach is in the core of the hereby-suggested methodology for the implementation of a more sustainable and efficient water management. Following this approach, emphasis is given on the functions of the ecosystem "as a whole" and on the variety of services that can be beneficial for human well-being, instead of just focusing on specific functions and relevant beneficiaries. This enables us not only to better understand the total value of an ecosystem and its benefits for human welfare, but also to identify the complex links among actions that affect the function and balance of the ecosystem (deciding for example whether to utilize the water of a river basin), and the effects on various economic sectors and stakeholders (using the water of a river may yield certain benefits, i.e. income for farmers and agricultural products for consumers, on the one hand, but might destroy a wide variety of ecological values that a river can offer on the other hand).

Table 1
Total economic cost of water.

Nature of cost	Description
Financial cost	Capital cost, operation cost, maintenance cost and administrative cost.
Environmental cost	The environmental cost represents the costs of damage that water users impose on the environment and ecosystems and those who use the environment (e.g. a reduction in the ecological quality of aquatic ecosystems or the salinization and degradation of productive soils).
Resources cost	Resource cost represents the costs of foregone opportunities that other uses suffer due to the depletion of the resource beyond its natural rate of recharge or recovery (e.g. linked to the over-abstraction of groundwater).

Adopted from Koundouri et al. (2009).

Please cite this article as: Koundouri, P., et al., Development of an integrated methodology for the sustainable environmental and socio-economic management of river ecosystems, Sci Total Environ (2015), http://dx.doi.org/10.1016/j.scitotenv.2015.07.082