Environmental Science & Policy 66 (2016) 179–190

Contents lists available at ScienceDirect

Environmental Science & Policy

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

Ecosystem services for water policy: Insights across Europe

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ARTICLE INFO

Article history:
Received 19 April 2016
Received in revised form 2 September 2016
Accepted 12 September 2016
Available online 29 September 2016

Keywords:
Ecosystem services
River Basin Management Plan
Water framework directive
Stakeholders
Project OpenNESS

ABSTRACT

In this research we explored how the concepts and approaches of ecosystem services are currently used in water management in Europe, in the application of River Basin Management Plans (RBMP) developed for the EU Water Framework Directive (WFD). Five case studies have been considered, located in the River Basin Districts of the Po river (Italy), Scotland (United Kingdom), Scheldt river (Belgium), Danube river (Romania), Sado and Mira rivers and Ribeiras do Algarve (Portugal). These cases represent different regional contexts of application of this EU water policy, with specific socio-economic drivers and environmental issues. Each case study has developed an operational framework to analyse ecosystem services in practice together with a group of local stakeholders. In each regional case, we examined how EU water policy and RBMPs are implemented, considered legal and planning instruments from the national to the local scale, and we analysed the use of ecosystem service terms and concepts in the relevant planning instruments. In parallel, we explored the view of local stakeholders and water managers on the topic, collecting their opinion on three major aspects: the usefulness of the concepts and approaches of ecosystem services for WFD river basin management plans, the risks and benefits of their use, and the knowledge needs to put the concepts into practice. The major drawback of the ecosystem service approach seems to be the challenge for practitioners of understanding new concepts and methodologies, while the major advantages are that it highlights all the hidden benefits of a water body in good health and promotes multi-functionality and sustainability in water management. The results of this study provide a picture across Europe of the current use of the concepts of ecosystem services in the RBMP and relevant insight on the opinion of local stakeholders and water managers.

1. Introduction

Improving human well-being, while ensuring sustainable use of natural resources, is a challenge for decision making and policy design (Guerry et al., 2015). A central element is to recognise the dependence of human well-being from nature, i.e. the multiple benefits, or ecosystem services, that people obtain from ecosystems (MEA, 2005; TEEB, 2010).

Since 2000, the European Union has adopted an ambitious policy for the protection of all surface, groundwater and coastal waters through the Water Framework Directive (WFD, Directive 2000/60/EC). The WFD aims to protect and enhance the status of aquatic ecosystems and to promote sustainable water use. To achieve these ambitious goals, the Directive foresees the adoption of River Basin Management Plans (RBMP) and Programmes of Measures to reduce the pressures on aquatic ecosystems. While the concept of ecosystem services is not mentioned directly, the WFD clearly supports the protection of ecosystems to secure long-term availability of water resources and benefits from aquatic ecosystems.

More recent EU strategies, also affecting water policy, have called attention to the central role of ecosystems and biodiversity in ensuring current and future human well-being. The Biodiversity Strategy (European Commission, 2011) aims at halting the loss of biodiversity and the degradation of ecosystem services, recognising their fundamental contribution to human health and economic

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http://dx.doi.org/10.1016/j.envsci.2016.09.006

prosperity. The Climate Adaptation strategy (European Commission, 2009) stresses the need of increasing the resilience of biodiversity and water-related ecosystems, exploiting the co-benefits of measures to fight global warming. Finally, the Blueprint to safeguard Europe's water resources (European Commission, 2012a) suggests to include ecosystem services in the cost-benefit analysis of water measures, and to adopt measures that foster ecosystem services for mitigating the effects of floods and droughts, such as natural water retention measures.

To put ecosystem service concepts into practice, evidence, methodologies and guidelines are needed (Polasky et al., 2015). At the European scale the MAES Working Group has suggested an analytical framework for the implementation of the ecosystem service approach in the EU (Maes et al., 2016). Currently, the EU FP7 research projects OpenNESS (2016), OPERAs (2016) and ESMERALDA (2016) are studying how to make the ideas of ecosystem services and natural capital operational based on the experience of concrete case studies and assessments; and the MARS (2016) and GLOBAQUA (2016) projects are applying the concepts of ecosystem services to support EU water policy.

Several recent studies have examined the potential of ecosystem service approaches for achieving the objectives of EU water policy (Grizzetti et al., 2016; Vlachopoulou et al., 2014; COWI, 2014; ESAWADI, 2010; Martin-Ortega, 2012), by considering the co-benefits of measures and facilitating the integration of policies.

While several studies have reflected on the potential of using the ecosystem services concept in the implementation of the WFD, less evidence is available on the real use of the ecosystem services approach in the current applications of RBMPs. To analyse the current uptake of the concepts, we focussed on two aspects: the formulation in official policy documents (legal acts, planning instruments, national guidelines) and the point of view of the local managers and practitioners, who are responsible for or affected by the water policy.

The objective of this study was to analyse and compare how the concepts of ecosystem services are currently used in the application of River Basin Management Plans of the EU Water Framework Directive across Europe, considering both the policy documents and the opinion of stakeholders. The stakeholders included water managers responsible for the implementation of the WFD, local actors and NGOs, and technical and scientific experts. The research, which is part of the EU FP7 project OpenNESS, was conducted in five case studies representing a wide range of water management situations across Europe: Gorla Maggiore in Italy, Loch Leven in United Kingdom, Lower Danube in Romania, Stevoort in Belgium, and Sudoeste Alentejano/Costa Vicentina in Portugal.

The paper is organised as follows. After a brief presentation of the methodology (Section 2), we describe and compare how the WFD has been implemented in the five case studies across Europe (Section 3), and how the concepts of ecosystem services have been adopted in the relevant planning instruments for the implementation of the RBMP (Section 4). Then, we analyse the opinion of the local stakeholders on the use of ecosystem services concepts and approaches for the RBMP (Section 5). Finally, we summarise the outcomes of the analysis and draw some final recommendations (Section 6).

2. Methodology

2.1. Structure of the analysis

In the OpenNESS project, the case studies (27 in total) cover different social-ecological systems; they are led by a team of national researchers and include collaborative work with local stakeholders. A Case Advisory Board (CAB) is established in each case study involving key stakeholders in the specific policy and decision-making context of the case study. The OpenNESS case studies work since 2013 to operationalise the ecosystem services concepts into real-world applications using a range of spatially-explicit methods to identify, quantify and value ecosystem services. The design and results from this research is shown and discussed regularly with the local CABs. As a result of this process both the researchers and the stakeholders have a well-informed opinion of the potential of analysing ecosystem services to support land, water or urban management. The work presented in this paper involved 5 OpenNESS case studies (see Section 2.2) whose topic of research was related to water resources and river basin management. Therefore the case studies considered have been developed in the same EU project framework (OpenNESS), with a similar mechanism of interactions between researchers and stakeholders (CABs meetings), and the opportunity for the researchers to develop common understanding and shared terminology in the use of ecosystem service concepts, through regular project meetings.

The analysis shown in this paper consisted of two parts: the study of the normative and planning documents and the examination of stakeholders' opinions. The work was conducted in each case study by the respective research team, according to a common structure, and coordinated through dedicated workshops.

In the first part of the analysis, each case study considered the legislative framework and the institutional setting of the application of the RBMP, identifying the relevant planning instruments. The objective was to describe how the RBMP of the WFD is implemented in the country and at the specific scale of the case study. This was instrumental to identify the planning instruments that correspond to the RBMP and additional planning instruments implementing the RBMP at the local scale. It also included an institutional analysis (map the administrations involved in the implementation). Our analysis covered the first RBMP and the proposal for the second RBMP, which was available for public consultation in autumn 2015. Then, in the official documents selected, we examined how the terms and concepts of ecosystem services were used. This involved the consideration of different geographical scales (EU, national, regional, local). In most of the case studies, the language of legal acts and planning instruments and the name of the competent authorities are not in English; in the results we provide an English translation and report the original names in Supplementary material S1.

In the second part of the analysis, we examined the view of the stakeholders on the use of the concepts of ecosystem services for the RBMP. The people consulted were the members of the respective CABs[1] (the consultation took place between January 2015 and November 2015). They were asked three questions (through focus groups, interviews or surveys):

1. Can the ecosystem services approach be useful for the River Basin Management Plan? Why?
2. What are the risks and benefits of using the concept of ecosystem services in the integrated water management?
3. What are the knowledge needs to put into practice the concepts of ecosystem services?

The answers of stakeholders were summarised considering three groups of interest: 1) water management institutions (public institutions); 2) local actors and NGOs; and 3) scientific and

[1] In the Sudoeste Alentejano and Costa Vicentina also stakeholders outside the CAB were contacted, as the focus of the case study is not primarily on water management.

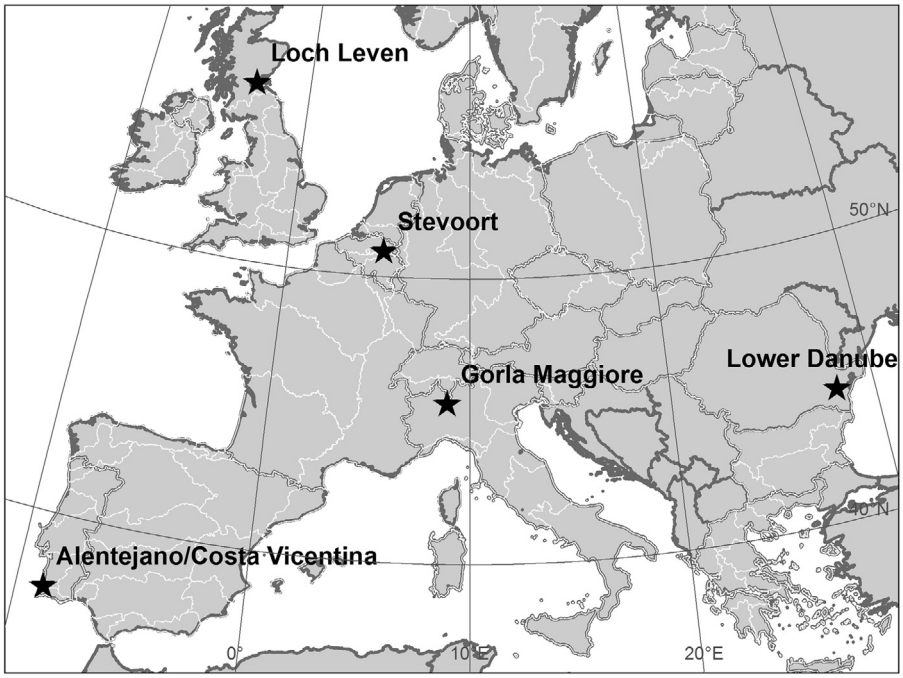

Fig. 1. Location of the case studies across Europe. The white lines delimitate the River Basin Districts defined under the WFD.

technical experts. The latter include researchers and consultants in the CAB, such as engineers, biologists, economists, having a technical knowledge but not a specific interest as users or managers. We adopted these three categories to represent the main interests of stakeholders groups in the CABs, also to provide a simple and meaningful classification considering the number of respondents per case study (on average CABs were composed by around 10 people per case study).

Each case study reported on the respondents (48 in total) and the way (meeting, interview or survey) in which the responses were collected. The opinions of the stakeholders were transcribed (and translated into English) without any interpretation by the researchers. Then they were classified according to five major themes: opinions related to 1) integration of policies and objectives; 2) understanding of ecosystem service concepts and appreciation of benefits; 3) (economic) values and methods for valuation; 4) management and measures; 5) communication, participation and awareness (Fig. 2). These themes were chosen a posteriori considering the opinions collected and because they relate to the main steps of the river basin planning cycle, (namely: 1) policy objectives; 2) characterisation of the river basin; 3) monitoring and programme of measures; 4) implementation of water pricing policies and economic instruments; and 5) communication and public participation, Fig. 2). The identification of the five themes and their correspondence with the steps of river basin planning cycle was discussed in a dedicated workshop by all researchers participating to the analysis. The five themes were adopted in order to perform a semi-quantitative comparison of stakeholders' opinions and provide recommendations on the use of ecosystem service concepts relevant to the different steps of river basin management. The classification of stakeholders' answers according to the five themes was done centrally by two researchers, to ensure consistency, and also independently per case study by the local research team, to ensure correct interpretation of answers. The discrepancies were discussed to agree on a final classification.

2.2. Case studies description

The research was conducted in five case studies across Europe (Fig. 1); they are named Gorla Maggiore (Italy), Loch Leven (United Kingdom), Lower Danube (Romania), Stevoort (Belgium) and Sudoeste Alentejano/Costa Vicentina (Portugal), and are located in the River Basin Districts of the Po river, Scotland, Scheldt river, Danube river, and Sado & Mira rivers/Ribeiras do Algarve, respectively. A description of the research carried out in the project OpenNESS in each case study and the main aspects relevant for the RBMP are presented in Table 1. The first results of the research (described in Table 1) can be found in Liquete et al. (2016), Masi et al. (2016), Reynaud et al. (2016), Rizzo et al. (2016) for Gorla Maggiore. These case studies represent different regional contexts of application of the EU water policy, with specific socio-economic drivers and environmental issues.

3. Implementation of the water policy in the 5 case studies

We first examined how the WFD has been implemented in the five case studies, to identify the relevant planning instruments corresponding to the implementation of the RBMP at the scale of the case studies, as well as the competent authorities and institutions involved.[2] Detailed information for each case study is provided in Supplementary material S1.

3.1. Case study in Italy

In Italy, the national law transposing the WFD (D.lgs. 152/2006) divides the territory in eight river basin districts. In each district the land-water policy is coordinated by a river basin plan composed of sectoral plans, among which the management plan (the RBMP required by the WFD) and the flood risk management

[2] The analysis was carried out in autumn-winter 2015.

Table 1
Description of the case studies considered in the analysis and main aspects relevant for the River Basin Management Plan.

ID	Case study & *River Basin District*	Research objectives in the project OpenNESS	Aspects relevant for the River Basin Management Plan (WFD)	Main ecosystem services under investigation
IT	Gorla Maggiore (Italy), *Po RBD*	The case study investigates the multiple benefits in terms of ecosystem services of a green infrastructure (constructed wetlands) to treat combined sewer overflow in Gorla Maggiore.	The green infrastructure (*nature-based solution*) contributes to multiple strategic objectives for the integration of policies in the basin management.	• Water purification • Flood regulation • Habitat for biodiversity • Recreation
UK	Loch Leven (United Kingdom), *Scotland RBD*	The research examines whether the restoration or improvement of environmental quality, driven by the RBMP goal of achieving good ecological status, can lead to net socio-economic benefits.	If the research can show specific RBMP targets are relevant indicators of ecosystem service value, then this provides important evidence to strengthen local support to the RBMP *Programme of Measures*.	• Recreational fishing • Tourism
RO	Lower Danube River (Romania), *Danube RBD*	The case study addresses the conflicts and trade-offs of sectoral multilevel policies objectives (e.g. navigation, hydropower, food production, water quality, flood protection, biodiversity conservation) for improvement the management plan of the Lower Danube River Watershed.	*Integration of different policies* and regulatory frameworks which sometimes are contradictory in the same area.	• crop and animal production, fish and timber • angling, hunting, aesthetic value, recreation • water quality, flood protection, nutrients retention, climate regulation, biodiversity
BE	Stevoort (Belgium), *Scheldt RBD*	Stevoort has been designated as a flooding area. The case study explores the ways in which the ecosystem services approach can help to support the planning process and communication.	The case study analyses the *multi-functionality* of the flooding area, the results can support the integration of multiple objectives and policy in the river management plan.	• Flood regulation • Water regulation Soil retention Biodiversity • Extensive agriculture, timber production • Recreation and tourism • Aesthetic value
PT	Sudoeste Alentejano & Costa Vicentina (Portugal), *Sado and Mira RBD & Ribeiras do Algarve RBD*	The case study aims to develop tools to enable the operationalization of ecosystem services and natural capital concepts to support the sustainable management of Parque Natural do Sudoeste Alentejano e Costa Vicentina.	The results of the study can support the *assessment of planning options*. In particular, the development of a recreation potential map, compatible with the protection of the natural capital and preservation of the aquatic ecosystems of the park.	Recreation Pollination Cultural services Provision of food Habitats for species

plan, which addresses the obligations of the Floods Directive (Directive 2007/60/EC). The management plan includes the plans for water protection (quality and quantity) developed by the Regions located in the territory of the river basin (a total of 20 Regions in Italy). The integrated water supply system is managed by optimal territorial areas (ATO) at the sub-regional level through specific planning instruments.

The case study of Gorla Maggiore is located in the North of Italy, in the catchment of the Olona River, which falls under the Po RBMP. The land and water resource planning is under the authority of the Lombardy Region, which for the implementation of the environmental quality objectives has adopted River Contracts as local strategic planning instruments in different sub-basins, involving the local authorities (Provinces, Communes, ATOs) and institutional stakeholders (such as the Regional Environmental Protection Agency, ARPA Lombardia, and the Po River Basin Authority). The River Contract of the Olona-Bozzente-Lura was established in 2003. The strategic objectives of the River Contract are: 1) reduction of water pollution; 2) reduction of flood risk; 3) restoration of landscape, environmental and urban systems relative to river corridors; and 4) sharing of information and knowledge on water. The overall objective of the programmatic instrument is to implement the requirements of the WFD, involving the local institutional actors and better integrating the sectoral planning strategies. The most recent programme of actions was adopted in 2014 (regional act, Delibera n.2347 12/09/2014).

3.2. Case study in Scotland, United Kingdom

In Scotland, the WFD was transposed into law by the Water Environment and Water Services Act (WEWS) 2003 (Scottish Government, 2003). The Act was supplemented by the Water Environment (River Basin Management Planning: Further Provision) Regulations 2013 (Scottish Government, 2013) and the Cross-Border River Basin Districts (Scotland) Directions 2014. The Acts established the RBMP process to achieve environmental improvements to protect and improve Scotland's water environment in a sustainable way. The Acts set out the responsibilities of the Scottish Environment Protection Agency (SEPA) for producing and implementing the RBMPs for the Scotland and the Solway Tweed River Basin Districts (RBDs), in co-ordination with a wide range of organisations with interests in the water environment. The area of the two RBDs has been divided into 11 sub-basins, which drain into Scotland's main estuaries (firths) or coastal waters. Within each of the sub-basins multi-stakeholder area advisory groups were established by SEPA in 2007 to contribute to the development and delivery of RBMPs within their area. A national advisory group and diffuse pollution management advisory group were also established to ensure effective co-ordination at the national scale. To support implementation of the first river basin management plans, area management plans were developed by the area advisory groups in each sub-basin district. The purpose of these plans and their associated catchment profiles was to help co-ordinate on-the-ground action within each catchment to enable the river basin planning objectives to be achieved.

The case study focuses on Loch Leven which is in the River Leven catchment which is within the Forth sub-basin district in the Scotland RBD. Loch Leven has been a high profile part of Scotland's water environment due to its designation as both a National Nature Reserve and Site of Special Scientific Interest. The Loch Leven Catchment Management Group (LLCMG) was established in 1995 and developed its first Catchment Management Plan in 1999 (LLCMG, 1999), with a primary aim of reducing the phosphorus pollution to the loch to reduce the frequency and intensity of algal blooms and promote ecological recovery.

3.3. Case study in Romania

In Romania, the existing institutional arrangements for the implementation of the WFD involve multiple levels: the International Commission for Protection of Danube River (ICPDR) at the international scale, the Romanian Waters National Administration at the country level, and the watershed management units at the river basin scale. The territory is divided into eleven regional watershed management units, for which river basin management plans are developed. The Romanian Waters National Administration in cooperation with the National Agency for Environment Protection coordinates the water policy implementation in all management plans. The scientific and technical support is provided by two specialized and legally bound research institutes and other universities, research centres, professional organisations. In each watershed management unit, a River Basin Committee (RBC) is established involving representatives of major stakeholders: individual households, local authorities, county and regional governing bodies, fisherman associations, farmers, mining and other industries, services provider companies, scientists, educators, nature conservation NGOs (Vădineanu et al., 2013). RBC are designed and used as large platform for discussion, learning, analysis and deliberation on multiple options regarding different water management issues (Vădineanu and Preda, 2008). The case study is a regional complex system covering the Romanian part of the Lower Danube Wetlands System. It includes Danube River stretch, lakes, wet meadows, alluvial forests, agricultural polders, fish ponds. The complex comprises several protected areas like Natura 2000 sites, Danube Delta Biosphere Reserve, Small Island of Braila Natural Park.

3.4. Case study in Belgium

In Belgium, the federal government is responsible for the economic aspects of drinking water provision and has environmental responsibility for coastal and territorial waters (European Commission, 2012b), while the regional governments are responsible for the water and environmental policies in their own territory. All four Belgian River Basins Districts (RBD) cross international and/or regional administrative boundaries.

The case study Stevoort is located in the Demer sub-basin in the Scheldt RBD, within the Flemish region. For the implementation of the WFD in the Scheldt RBD, Belgium collaborates with France and the Netherlands through the International Scheldt Commission (Treaty of Ghent, 3 December 2002). At the national level, the coordination of water policy implementation among the Flemish, Walloon and Brussels Capital regional governments is facilitated by the Co-ordination Committee for International Environmental Policy (CCIEP). The Flemish Government develops the water policy vision and objectives for its region and each RBD through the Water Policy Note (WPN). Within the WPN, the Decree on Integrated Water Policy for the Flemish region transposes the WFD and Flood Directive. It distinguishes four levels in Flanders: the RBD of Scheldt and Meuse; 4 river basins in the Flemish region; 11 sub-basins ('bekkens'); and 103 sub-sub-basins ('deelbekkens'). The decree establishes the Coordination Committee on Integrated Water Policy (CIW) that is responsible for the preparation and implementation of the RBMPs and the stakeholders' consultation for the Flemish Region. It includes administrative entities, representatives of local water management and water companies. Currently, the CIW is in the process of creating a new RBMP for the Scheldt RBD and the Demer sub-basin for the period 2016–2021.

3.5. Case study in Portugal

In Portugal, the WFD was transposed into the national legislation by the Water Law (Lei n.58/2005, then updated by the Decreto-Lei n.130/2012). Portugal comprises 10 RBDs, four of which are shared with Spain. In 2007 River Basin Administrations (ARH) were created, vested with administrative and financial autonomy. In 2012 the continental ARHs have been integrated under the Portuguese Environment Agency (APA). ARHs are responsible for water planning and management, and also play a role in licensing water uses, monitoring quality of water bodies and in the implementation of water taxes. The River Basin District Councils, established by the Water Law, have an advisory role in the development of the RBMPs. The Water and Waste Services Regulatory Entity (ERSAR) defines urban water cycle water tariffs and objectives for the quality of water services. The General Direction of Natural Resources and Maritime Safety and Services (DGRM) is responsible for the licensing of activities in the public maritime space, as well as for the protection of marine resources, fisheries, aquaculture, maritime and port safety. Monitoring of the coastal and transitional waters is undertaken by the Portuguese Institute of the Sea and Atmosphere. The Portuguese water planning system comprises the following water plans: 1) the National Water Plan (Plano Nacional da Água – PNA), that covers the whole territory of Portugal; 2) the RBMPs (Planos de Gestão de Região Hidrográfica – PGRH), which cover the watersheds integrated in a water district; and 3) the Specific Water Management Plans (Planos Específicos de Gestão da Água – PEGA) that are complementary to the PGRH and which may be of a territorial scope. The 2nd cycle RBMPs (corresponding to the period 2016–2021) are under preparation by APA, with the support of the Regional Directorates (ARH).

The case study of Sudoeste Alentejano/Costa Vicentina is located in the RBDs of Sado e Mira (PTRH6) and of Ribeiras do Algarve (PTRH8). It is under the jurisdiction of two different River Basin Administrations: ARH Alentejo and ARH Algarve.

3.6. Observations across Europe

In all case studies, the implementation of the WFD involves several administrative levels from the supranational (notably in Romania, Belgium and Portugal), to the national, regional and river basin or catchment scale. Generally, a central implementation agency/institution is in charge of developing the guidelines for the RBMPs, which are then implemented specifically per RBD or sub-basin. The institutional organisation and distribution of responsibilities differs from case to case. In Italy and Belgium several institutions are involved in the implementation, not only following administrative boundaries (e.g. regions and provinces) but also specific sectors or roles (e.g. drinking water). In the other cases, even if there can be many actors involved (e.g. at catchment scale in Scotland or at national scale in Romania) the implementation bodies seem more centralised, especially in Portugal. In all cases the principle of the WFD is respected, which fosters broad consultation and engagement processes at local scale. Policy implementation is also determined by the specific regional context, like the relevance of international cooperation in Romania, the interest on dealing with human pressures at local scale in Scotland, or the institutional instability (change of the competent authorities during the WFD implementation) in Portugal.

4. Use of ecosystem services concepts in the River Basin Management Plans

From the analysis of the regulatory instruments, we selected the relevant planning documents corresponding to the RBMPs and, when possible, implementation plans at the local scale. We considered the first RBMP (2009–2015) and the proposal for the

second cycle (2016–2021) available for public consultation.[3] A detailed list of the documents consulted for each case study is provided in Supplementary material S2.

4.1. Case study in Italy

In the first Po RBMP (Po River Basin Authority, 2010) the terminology of ecosystem services is not directly adopted in the general plan, but the Programme of Measures is structured in four pillars: 1) purification (waste water treatment); 2) nitrates and agriculture; 3) water balance; and 4) ecosystem services. The latter includes the measures for landscape management and river restoration ("strategy to improve the hydromorphological quality of water bodies, halt the biodiversity loss and increase the purification capacity of water bodies in the river basin district"). In addition, "enhancing biodiversity and restoring ecosystem services" is one of the sustainability objectives against which the RBMP is assessed in the Strategic Environmental Assessment (SEA), with reference to the EU Communication on halting biodiversity loss (COM(2006)216).

The guidelines for the preparation of the second RBMP (2016–2021) by the Po River Basin Authority (2013), which integrates European and national guidelines, point out that the measures for the restoration of the ecological functioning of aquatic systems, grouped under the pillar "ecosystem service", constitute an innovative aspect on the WFD, but have not received sufficient financial coverage in the first cycle of implementation. In the document, ecosystem services are mentioned also in relation to biodiversity conservation and economic valuation, reporting a lack of scientific methodological references for the economic valuation of ecosystem services and "disproportionate costs".

The proposal for the second Po RBMP (Po River Basin Authority, 2014) states that water abstractions, hydromorphological alterations and water temperature changes cause relevant impacts for the "loss of biodiversity and the degradation of aquatic ecosystem services". The Programme of Measure reaffirms the adoption of the four pillars, 1) purification, 2) nitrates and agriculture, 3) water balance, and 4) ecosystem services, for structuring the measures in the operational plans, and the economic valuation of ecosystem services and water uses is mentioned, but without further details. Moreover, the proposal for the Flood Risk Management Plan (which is one of the sectoral plans of the Po RBMP) refers to interventions of morphological restoration, which fall under the "ecosystem services" pillar of the RBMP. These measures consist of landscape management and river restoration to improve the hydromorphological quality, halt the biodiversity loss, and improve the natural purification capacity of the river system, and represent the 95% of the plan resources.

In the local planning instrument, the River Contract of Olona-Bozzente-Lura (regional law of Regione Lombardia L.R. 2/03), the concepts of ecosystem services are not explicitly mentioned, but one can argue that the ecosystem service approach is at the core of the strategy. To achieve the main strategic objectives (pollution reduction, flood risk reduction, river system restoration, and water information and knowledge sharing), the River Contract advocates interventions of restoration that support the multi-functionality of the riverine system, mentioning ecological, social and economic dimensions of the ecosystem. The Gorla Maggiore case study is included an innovative pilot case in the document. In the recent Programme of actions for 2014 the term of ecosystem services is explicitly used in 2 out of 48 specific activities.

[3] At the time of writing of this paper, the second RBMPs are in the process to being formally adopted.

4.2. Case study in Scotland, United Kingdom

Whilst ecosystem services concepts are embedded within the approach taken to develop the first Scotland and Solway Tweed RBMPs published in 2009, 'ecosystem services' terminology was not used explicitly. SEPA's preference is to use the term 'multiple benefits' to describe the ways in which people benefit from a well-protected and improved water environment over ecosystem services terminology as it is easier to relate to.

The overall approach carefully considered individual 'services' and the importance of water for the economy (tourism, angling, fish/shellfish farming, aquaculture, food and drink manufacture, renewable energy, freshwater provision), well-being (freshwater provision and waste recycling, leisure and recreation) and wildlife (biodiversity and productivity conservation) were discussed in-depth. The term 'ecosystem services' was only used when considering the impact of different actions when "preparing Scotland for a future climate". Here an evaluation was undertaken to determine if an action could make wildlife more or less resilient, help sustain economically important water uses, or enable the water environment to continue to recycle wastes.

In implementing the first RBMPs, a multiple benefits approach has been taken to delivering environmental improvements, which can be viewed as a version of the ecosystem services approach. Scotland's pilot catchment work to deliver catchment-scale restoration together with the Forth and Clyde multiple benefits projects are clear examples of this.

In the lead up to the publication of the second Scotland and Solway-Tweed RBMPs, the economic characterisation of Scotland's river basin district was published in the 2013 statutory consultation 'current condition and challenges for the future'. For this economic characterisation, Scotland used an ecosystem services approach to illustrate the social, economic and ecosystem benefits from protecting and improving the water environment. Maps of individual ecosystem services were published as an interactive data analysis tool, enabling readers of the consultation to identify specific services delivered by individual water bodies.

The second Scotland and Solway Tweed RBMPs published in 2015 continue to avoid explicit use of the 'ecosystem services' terminology, but continue to highlight the importance of Scotland's water environment and the multiple benefits which support health, wellbeing, wildlife and sustainable growth of the economy. As with the first RBMP, the second RBMP also emphasises collaborative working between public bodies, businesses and catchment partnerships to achieve water environment improvements which deliver multiple benefits.

4.3. Case study in Romania

The ecosystem services concept is not explicitly used in the national RBMP, which consists in a synthesis of the 11 River Basin Management Plans, covering Romanian part of the Danube River basin. Also the regional management plan does not use explicitly ecosystem services concept (ANAR, 2009b). In both documents "water services" term is used and defined as "all services provided for households, public institutions or any economic activity", like abstraction, impoundment, storage, treatment and distribution of surface water or groundwater, wastewater collection and treatment facilities which subsequently discharge into surface water. Nevertheless, it is recognized in the national RBMP, under problems and uncertainties chapter, that "the economic valuation of water services, according with the WFD, would require more than financial analysis of the costs associated with water supply and wastewater collection and treatment, heading towards an extensive accounting of both goods/'renewable resources' with market value (ex. drinking water, trade fishing, biomass, industrial

water use) and goods and services without market value (reducing impacts of extreme hydrological flows, biodiversity, recreation, water quality) provided by water bodies" (ANAR, 2009a).

Within the proposal for the second RBMP there is no improvement in the general operationalization of ecosystem service concepts. However, the integration of different strategies (e.g. energy strategy, sustainable development strategy, national strategy against desertification, national strategy for waste management), directives and national plans (e.g. national plan for regional development, aquaculture and agriculture, development plans, national development plan for environmental protection), aiming to protect aquatic ecosystems and to improve water quality, is the innovative approach of the second RBMP. The link with the Blueprint to Safeguard Europe's Water Resources (European Commission, 2012a) launched the idea that the natural water retention measures (through ecosystems restoration and land use changes) provide multiple benefits and services, such as improving water quality, reducing flood risk, controlling erosion, enhancing habitats and groundwater recharge. Also the link with other EU Directives (e.g Habitats and Birds Directives) led to the idea that "proper management of Natura 2000 sites from marine area will enhance the ecological state of marine ecosystems resulting other benefits like carbon sequestration and tourism" (ANAR, 2014a). Even in the proposal for regional RBMPs, it is mentioned that the local authorities and water companies can save money for water treatment due to the services (e.g. water purification) provided by protected ecosystems (ANAR, 2014b).

The analysis of the supranational management plan for entire Danube River District shows that water uses and services, like water abstraction (industry, irrigation, household supply), drinking water supply, wastewater discharge (municipalities, industry), hydropower generation, navigation, dredging and gravel exploitation, recreation, are important characteristics of the Danube River Basin District. Also, it is recognized that "wetlands/floodplains and their connection to adjacent river water bodies play an important role in the functioning of aquatic ecosystems by providing important habitats for fish as well as other fauna and have a positive effect on their water status. Connected wetlands/floodplains play a significant role when it comes to retention areas during flood events and may also have positive effects on the reduction of nutrients" (ICPDR, 2009).

Within the second RBMP for entire Danube River Basin District, it is mentioned the link with Green Infrastructure Strategy, which is a strategically planned network of natural and semi-natural areas managed to deliver a wide range of ecosystem services, floodplains being good examples of multiple ecosystem services provider (ICPDR, 2015).

4.4. Case study in Belgium

In the RBMP documents relative to the Scheldt basin (2010–2015) and the Demer sub-basin (Demerbekken 2008–2013), some ecosystem functions/services are considered, such as the filtering, retention and storage of fresh water, flood regulation and prevention, biodiversity and various recreational services. However the concept of "ecosystem service" as such is not used, except a small link in the Scheldt RBMP (2010–2015) that suggests to explore the concept of "blue services", interpreted as ecosystem services provided by water systems.

In the proposal for the second Scheldt RBMP (2016–2021) "blue services" are mentioned and expanded to "blue-green services", indicating that these concepts can be used to identify win–win situations between water management and agriculture, especially from an economic perspective, but there is no further elaboration on this idea or its applications. In the Demerbekken RBMP (2016–2021) the concept of ecosystem services is mentioned only once. Through the management of ecosystem services, it is suggested that win–win situations can be made between natural water storage, nature development, recreation and agriculture. Stakeholders in various categories are encouraged to take appropriate actions which should be beneficial for the water systems and the landscape.

Finally, in the document "Ecological Vision for the Stevoort sub-sub-basin" (2016) the Flanders Environment Agency explores how the concept of ecosystem services can be used to support cost-benefit analysis and environmental assessments, and makes reference to the research projects OpenNESS and ECOPLAN, working on ecosystem services quantification and valuation.

4.5. Case study in Portugal

The term "ecosystem services" is not used in any of the documents of the first RBMP of Sado e Mira (RH6) and Ribeiras do Algarve (RH8), although many of the themes addressed in the plans are directly linked to individual ecosystem services, such as water supply, habitats for species and biodiversity conservation, flow regulation, nutrient cycling, protection from extreme events, such as floods, droughts and fire. In the part of the plans dealing with the economic analysis of water uses, a clear reference is made to the 'social value of water', that is related with the need to ensure universal access to water to satisfy basic human needs at a socially acceptable cost.

The concept of ecosystem services is used in the Environmental Reports associated with the Strategic Environmental Assessment (SEA) process of both plans. The SEA was organized around 5 main sustainability themes, one of them being Biodiversity, formulated as: "Safeguarding the adequate provision of ecosystem goods and services". In the SEA reports there is a clear reference to the impacts of proposed measures in specific ecosystem services associated with aquatic habitats, such as water regulation, soil retention, nutrient cycle regulation, biodiversity refugee and prevention of catastrophic events. The main conclusion in this respect is that "although the RBMP is not specifically targeted to meet this sustainability objective [safeguarding ecosystem goods and services] many of the proposed measures contribute to its achievement".

The expression 'ecosystem services' appears in the second cycle RBMP (2016–2021) of both RH6 and RH8, but only in the framework and general aspects, and only as a reference to other strategic documents that use the concept of ecosystem services, such as the National Strategy for the Sea (ENM 2013–2020). The Programme of Measures of the RBMPs makes reference to measures aimed at "promoting investments in natural capital in the areas of Natura 2000 sites", to be implemented through investments in green infrastructure, biodiversity credits and payments for ecosystem services.

4.6. Observations across Europe

From the analysis of the five regional cases, the picture that emerges at the European scale shows that the reference to ecosystem services was generally absent in the first cycle of the RBMPs, and that it has started to appear in the second cycle. This has been influenced by the adoption of strategic documents at the European level, in particular the Biodiversity Strategy (European Commission, 2011), the Climate Adaptation (European Commission, 2009) and the Blueprint to safeguard Europe's water resources (European Commission, 2012a), which explicitly refer to ecosystem services.

In the cases analysed, the concepts of ecosystem services were considered beneficial to address win–win situations, i.e. measures that are advantageous for different policies or stakeholders groups

(for example in Belgium), or facilitate the integration of different policy objectives (for example in Italy). They are also used to emphasise the multi-functionality of measures (i.e. measures functional to different processes), for example water storage and filtration in the Belgian case, or hydromorphological functions and support to biodiversity in the Italian case, or floodplains as provider of multiple ecosystem services in the Romanian case. In addition, ecosystem services come to light as criteria for impact assessment (Italy, Portugal and Belgium) and when dealing with the economic valuation or the recovery of costs for water services (Romania, Italy and United Kingdom). In other cases they are mentioned in relation to sustainability (United Kingdom, Italy) and biodiversity (Italy and Portugal).

When used, the ecosystem service concepts remain at a superficial level, without concrete indications on applications or methodologies. Though in all case studies water-related ecosystem services are thoroughly illustrated in the RBMPs, even when not directly called 'ecosystem services' (for example Romania and United Kingdom). The case of Scotland (UK) is interesting, as despite acknowledging the relevance of the concept of ecosystem services, the specific term is used sparingly because the term 'multiple benefits' is deemed to be easier to relate to and more widely understood. The Romanian case has a particularly utilitarian perspective which equals water services to water uses.

In conclusion, from the planning instruments analysed, it appears that the use of the concept of ecosystem services in water policy implementation is still in an explorative stage. Yet, water management authorities have high expectations from the adoption of ecosystem services approach, especially to integrate different policies objectives, identify synergies, invest in multi-functional measures, improve the cost-benefit analysis, and find trade-offs and better solutions for water management. At the moment there is no evidence on how the ecosystem service approach should be systematically used to frame, evaluate or communicate aspects related to the implementation of the RBMP. Here, the results of projects like OpenNESS can help supporting the practical implementation of the approach and the development of guidelines or tools for specific objectives.

5. Opinion of the local stakeholders

In the second part of the study we analysed the opinion of the stakeholders on the use of ecosystem service concepts and approaches for the RBMPs. (For previous studies on stakeholders' perspectives on the use of ecosystem service concept in the implementation of the EU water policy see Hauck et al., 2013; Brown et al., 2010; Spray and Blackstock, 2013). The stakeholders of the five case studies (48 respondents in total, of which 40% water managers, 25% local actors, 35% scientific and technical experts) were asked the same three questions. Overall we collected 231 opinions, 51 from local actors and NGOs, 94 from scientific and technical experts, and 86 from water managers (respondents were allowed to provide multiple responses per each question). To perform a semi-quantitative analysis, the opinions were classified according to five major themes related to the steps of the river basin planning cycle (Fig. 2). The results are reported in Tables 2–5 (the colour indicates the link between the theme and the corresponding step in the river basin planning cycle shown in Fig. 2).

5.1. "Can the ecosystem services approach be useful for the River Basin Management Plan? Why?"

Overall the stakeholders indicated that the ecosystem services approach can be useful for the RBMP, with less than 10% expressing disagreement or doubts (Table 2). The stakeholders argued that the approach can be useful to integrate different policy objectives, create win–win solutions, identify co-benefits, and support trade-off analysis. The concept can help identify social-ecological system interactions, increase the interdisciplinary knowledge, foster a holistic view of the problems, elicit all the benefits, and add the dimension of human well-being to the policy objective of good ecological status. Regarding the methods, the stakeholders indicated that the approach could enhance the role of economic instruments in the implementation of the WFD, to better estimate cost-benefits, and justify the costs of restoration. More generally, in terms of integrated water management, they highlighted that the approach could promote the sustainability of water use and natural capital, and support the implementation of measures, making more explicit the benefits and multi-functionality of measures. The approach could also promote participation of public and stakeholders to the process, and increase awareness and multi-disciplinarity.

Local actors gave more attention to stakeholders participation, while water managers were more interested to the integration of different policy objectives and management aspects. All stakeholder groups considered the vision brought in by ecosystem services (nature-society coupled system) and the valuation of all benefits from the ecosystem as an important asset for the RBMP.

5.2. "What are the risks of using the concept of ecosystem services in the integrated water management?"

The main risks identified by the stakeholders regarding the use of the ecosystem services approach in water management concerned definitions and methods (Table 3). The concepts and terminology were considered unclear, and could create misunderstanding or misinterpretation. It was also highlighted that there is

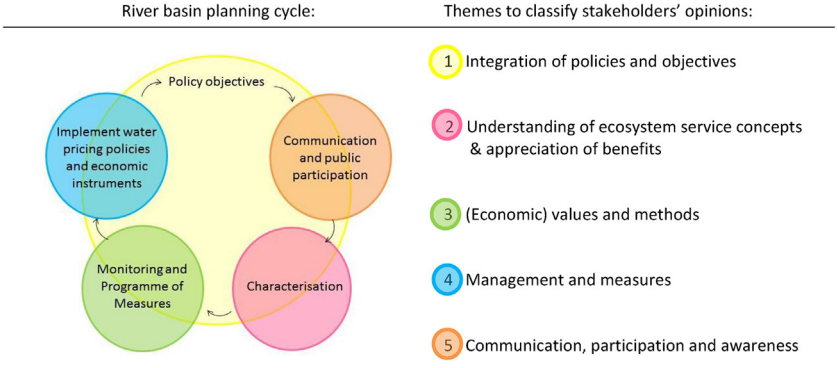

Fig. 2. Themes used to classify stakeholders' opinions, corresponding to major components of the River Basin planning cycle. The colours indicate the link between the theme to classify stakeholders' opinions and the corresponding step in the river basin planning cycle.

Table 2
Opinions of different stakeholders on the question 1: *"Can the ecosystem services approach be **useful** for the River Basin Management Plan? Why?"*(For interpretation of the references to colour in this table legend, the reader is referred to the web version of this article).

	The ecosystem service approach can be **useful** for the River Basin Management Plan to:	Local actors & NGOs						Scientific & Technical						Water Management						*All groups*
		BE	IT	PT	RO	UK	*Total*	BE	IT	PT	RO	UK	*Total*	BE	IT	PT	RO	UK	*Total*	
Theme	*Total*	*2*	*5*	*6*	*2*	*1*	***16***	*1*	*9*	*3*	*2*	*6*	***21***	*5*	*6*	*9*	*4*	*3*	***27***	***64***
1	Integrate different policies objectives, create win-win solutions, identify co-benefits, support the trade-off analysis	1	1				***2***	1	3	1			***5***	2	2				***4***	***11***
2	Understand interactions, increase the interdisciplinary knowledge, foster a holistic view of the problems, consider the nature-society coupled systems. Be applied in different contexts		1	1			***2***		1				***1***	1		1	3	2	***7***	***10***
2	Elicit benefits, consider multiple benefits, drive attention to benefit to people, add human well-being to the good ecological status			2			***2***		1	1		2	***4***			1		1	***2***	***8***
3	Integration of monetary and non-monetary value, include the value of biodiversity				1		***1***		1				***1***			1			***1***	***3***
3	Enhance role of economic instruments, estimate costs, recovery costs, cost-benefits, justify cost of restoration		1				***1***		1	1		1	***3***		2				***2***	***6***
4	Promote the sustainability of water uses and natural capital, support conservation										1	1	***2***		1	2			***3***	***5***
4	Support the implementation of measures, highlighting the benefits and multi-functionality of measures			1			***1***		2				***2***			2			***2***	***5***
5	Promote participation of public and stakeholders to the process, promote dialogue		1		1		***2***					2	***2***			1			***1***	***5***
5	Increase awareness, promote multidisciplinary thinking with more environmental perspective		1	2			***3***									1	1		***2***	***5***
	Not useful or express doubts	1				1	***2***				1		***1***	2	1				***3***	***6***

The colours indicate the theme to classify stakeholders' opinions and the corresponding step in the river basin planning cycle shown in Fig. 2.

a risk of the commodification of nature and of manipulating the valuation of benefits (to serve specific interests). Doubts were also expressed about the possibility of quantifying all types of ecosystem services. Methods for the quantification might be inappropriate or difficult, and economic valuation methods are not yet consolidated. Generally, taking a new approach represents a risk; therefore guidelines with proven case examples are needed. Some practical barriers were also highlighted, due to the often sectoral approach adopted in natural resource management. The poor understanding in the application and the lack of financial

Table 3
Opinions of different stakeholders on the question 2a: *"What are the **risks** of using the concept of ecosystem services in the integrated water management?"*(For interpretation of the references to colour in this table legend, the reader is referred to the web version of this article).
The colours indicate the theme to classify stakeholders' opinions and the corresponding step in the river basin planning cycle shown in Fig. 2.

	The **risks** of using the concepts of ecosystem services in integrated water management are the following:	Local actors & NGOs						Scientific & Technical						Water Management						*All groups*
		BE	IT	PT	RO	UK	*Total*	BE	IT	PT	RO	UK	*Total*	BE	IT	PT	RO	UK	*Total*	
Theme	*Total*	*2*	*3*	*4*	*2*	*1*	***12***	*1*	*12*	*3*	*2*	*5*	***23***	*4*	*5*	*4*	*3*	*4*	***20***	***55***
1	Might trigger conflicts between ecosystem services or stakeholders. Natural resource management is often dealt with a sectoral approach		1				***1***				1	1	***2***			2			***2***	***5***
2	The concepts can result unclear and vague, too broad, can create misunderstanding and misinterpretation, the terminology risks to be too technical and theoretical for an outsider	1		1			***2***		2	2			***4***	2	1		1	3	***7***	***13***
2	There is a risk of manipulating the benefits, not being objective, misuse, environmental bias. Not all ecosystem services can be quantified. The focus only on provisional services could be a barrier		1				***1***		4				***4***	1	1		1		***3***	***8***
3	Inappropriate methods, difficult to assess, adopting a new approach represents a risk (guidelines with proven case examples are needed)		1				***1***	1	3				***4***					1	***1***	***6***
3	Overestimation/underestimation of the ecosystem services (and their value), anthropogenic focus and risk of commodification of nature, economic valuation methods are not yet consolidated					1	***1***		2	1	1	2	***6***	1					***1***	***8***
4	Low competence of people; poor understanding in the application; regulatory, reputational, financial risks for companies not prepared to apply the concept in business strategies; lack of financial support			2	1		***3***		1			1	***2***		1	1			***2***	***7***
5	Manipulation of public opinion, also by media; the process of consultation may be long; lack of interest of some stakeholders	1			1		***2***					1	***1***		2		1		***3***	***6***
5	Dismissal of WFD basic principles and a return to the anthropocentric water management paradigm			1			***1***													***1***
	No risks envisaged															1			***1***	***1***

support could also hamper the application of ecosystem service approach. Finally, if concepts are unclear, public opinion could be manipulated, also by media, and this could be used to dismiss the basic principles of the WFD and cause a return to a more anthropocentric water management paradigm.

All stakeholders' groups were concerned by the risks related to the unclarity of ecosystem service concepts. Local actors were more worried about the consequences for participation and communication to the public, while scientists were more concerned by the risks related to inappropriate methodologies.

5.3. "What are the benefits of using the concept of ecosystem services in the integrated water management?"

Two major opportunities emerged from the stakeholders' opinions on the use of ecosystem service concepts in water management (Table 4). Firstly, the concept of ecosystem services makes more explicit the human-nature relationships, offering a wider holistic view. The approach can potentially help identifying and valuing all services, even those with less apparent benefits, showing synergetic benefits for society, the environment and the economy. For the WFD this offers an opportunity to go beyond the improvement in the status of water bodies, and link the policy targets with human well-being. Secondly, in the Programme of Measures, the ecosystem service approach may promote multi-functional measures and more efficient solutions. It could improve the valuation of benefits associated with measures and the cost-benefit analysis, justifying the costs of restoration. Some stakeholders' considered the ecosystem services concept a powerful communication tool to include the social perspective and well-being of local people.

Water managers were more sensitive to the potential benefits of using ecosystem service approaches in the implementation of water management and measures, while scientists additionally emphasised the integration of policy objectives and the understanding concepts and benefits.

5.4. "What are the knowledge needs to put into practice the concepts of ecosystem services?"

The stakeholders suggested several fields where knowledge on ecosystem services should be improved (Table 5), from the theoretical side, on the definitions of concepts and classification of ecosystem services, to the practical side, on the translation of concepts into practice through guidelines. Methods and tools for assessing ecosystem services are needed, including economic methodologies. The knowledge about ecological functioning and the link between ecological functions and ecosystem services is considered as crucial. For water management, information (based on monitoring) on the effectiveness of measures restoring/providing ecosystem services is needed, as well as training technical staff and policy makers, to foster capacity building. Finally, there is a need for good communicators (facilitators) and communication of concepts and methods to the public, to increase the awareness of benefits from nature and the risks of losing these.

From the opinions gathered, water managers identified knowledge needs in relation to concepts, methods, and practical implementations; scientists were concerned especially about knowledge needs in concepts and methods, while local actors were interested on how the communication to the public could be improved.

6. Lessons learnt and key messages

The development and implementation of the RBMP across the five case studies analysed in Italy, United Kingdom, Romania, Belgium, and Portugal is marked by the different distribution of responsibilities among national/regional institutions and the different consultation processes at the local scale. Each Member State also has a particular context that drives the spirit or objective of the planning instruments.

The concept of ecosystem services has been adopted in the planning instruments relative to the implementation of the RBMP

Table 4
Opinions of different stakeholders on the question 2b: *"What are the **benefits** of using the concept of ecosystem services in the integrated water management?"*(For interpretation of the references to colour in this table legend, the reader is referred to the web version of this article).
The colours indicate the theme to classify stakeholders' opinions and the corresponding step in the river basin planning cycle shown in Fig. 2.

	The **benefits** of using the concepts of ecosystem services in integrated water management are the following:	Local actors & NGOs						Scientific & Technical						Water Management						*All groups*
		BE	IT	PT	RO	UK	*Total*	BE	IT	PT	RO	UK	*Total*	BE	IT	PT	RO	UK	*Total*	
Theme	*Total*	*1*	*4*	*1*	*1*	*1*	***8***	*1*	*10*	*4*	*2*	*9*	***26***	*5*	*4*	*4*	*2*	*4*	***19***	***53***
1	Support synergetic benefits for society environment and economy, balancing different uses and protections of ecosystems (identify alternatives). Help inter-disciplinary science and policy-science integration. Create win-win solutions		2				***2***	1	1			4	***6***		1				***1***	***9***
2	The concepts of ecosystem services can help understanding the link human-nature, provide a framework for integrated water management considering a wider holistic view				1		***1***		3	2			***5***			1		1	***2***	***8***
2	The ecosystem service approach can identify and value all services (also those that are ignored, or specific local services), address benefits not easily apparent, go beyond the improvement in the status of water bodies		1	1			***2***		4		1	1	***6***	2				1	***3***	***11***
3	Tools for rapid assessment of ecosystem services										1		***1***							***1***
3	Highlight the value of works and protected areas, justify costs, highlight values ignored									1			***1***		2				***2***	***3***
4	Support integrated water management; foster sustainability and sustainable use of water resources; promote multi-functional and more efficient solutions								1	1		2	***4***	2	1	2	1	2	***8***	***12***
4	Evaluate the benefits associated with measures; consideration of all costs and benefits of a certain measure; inclusion of different users and sharing of costs of measures; justify exemptions								1			1	***2***	1		1			***2***	***4***
5	Include the social perspective; powerful communication tool	1					***1***					1	***1***				1		***1***	***3***
5	Make people appreciate the territory, improve well-being of local people raising their awareness		1				***1***													***1***
	No benefits envisaged					1	***1***													***1***

Table 5
Opinions of different stakeholders on the question 3: *"What are the **knowledge needs** to put into practice the concepts of ecosystem services?"*(For interpretation of the references to colour in this table legend, the reader is referred to the web version of this article).
The colours indicate the theme to classify stakeholders' opinions and the corresponding step in the river basin planning cycle shown in Fig. 2.

	The **knowledge needs** to put into practice the concepts of ecosystem services are the following:	Local actors & NGOs						Scientific & Technical						Water Management						*All groups*
		BE	IT	PT	RO	UK	*Total*	BE	IT	PT	RO	UK	*Total*	BE	IT	PT	RO	UK	*Total*	
Theme	*Total*	*2*	*6*	*4*	*1*	*2*	***15***	*1*	*18*	*3*	*1*	*1*	***24***	*5*	*4*	*5*	*2*	*4*	***20***	***59***
1	Knowledge on how to integrate the concept on water management and water policy. Data on ecosystem services and decision support tools based on spatial data	1		1			***2***		1	1			***2***					1	***1***	***5***
2	Clarify and define the concepts, provide a classification of the ecosystem services, provide guidelines, Understanding the concepts of ecosystem services, translate the concepts into practice		2				***2***		5		1		***6***	4	1			1	***6***	***14***
2	Link ecological functions and ecosystem services, knowledge of the ecological functioning is needed, more technical information/modelling on system functioning	1					***1***	1	3				***4***		1				***1***	***6***
3	Methods and tools for assessing ecosystem services								3			1	***4***	1					***1***	***5***
3	Knowledge about the value of ecosystem services, stable and official economic methodology, assess the costs and benefits of the loss/reintroduction of ecosystem services			1		1	***2***		2	2			***4***			2		1	***3***	***9***
4	Training technical staff in water management and policy makers, capacity building		1				***1***		1				***1***		1	1	1		***3***	***5***
4	Information (based on monitoring) on the effectiveness of measures restoring/providing ecosystem services								1				***1***			1		1	***2***	***3***
5	Increase the dissemination of concepts to different actors; good communicators (facilitators) and communication methods to the public		2				***2***		1				***1***			1	1		***2***	***5***
5	Awareness of benefits from nature and risk of losing ecosystem services; understand when water quality starts to undermine ecosystem services; link producer of an ecosystem service with the beneficiaries		1	2	1	1	***5***		1				***1***		1				***1***	***7***

in all cases at least since the second cycle of the RBMPs, although sometimes the term is not explicitly mentioned. The context of application of ecosystem service concepts is usually related to the inter-sectoral integration of policies, the identification of synergetic uses of the water bodies, the multi-functionality of measures, the support to biodiversity conservation, or the need of more comprehensive economic valuation methods, to improve the cost-benefit analysis of the application of water policy. There are high expectations from water management authorities, but still there are not clear indications on how to apply the ecosystem service concepts in the implementation of RBMPs.

Most of stakeholders for water management consulted in this study across Europe think that the ecosystem services approach can be useful for the RBMPs, especially to integrate policies, to identify synergies and trade-offs, to foster a holistic and sustainable view of the water issues and to drive attention to human benefits from conserving nature. The major drawback of the ecosystem service approach seems to be the challenge for practitioners of understanding new concepts and methodologies, while the major advantage could be that it can highlight all the hidden benefits of a water system in good health and to promote multi-functionality and sustainability in water management. Most of the knowledge needs identified to put ecosystem service approaches into practice relate to concepts, guidelines and valuation methods.

Future research and guidelines for policy implementation should address these needs to overcome the knowledge gaps and streamline the ecosystem service approach in water management. The direct application of ecosystem service concepts linked to management issues (such as the research developed by OpenNESS) can provide useful insights to reinforce the implementation of water policies, integrating cross-sectoral interests and well-being concerns. The exploration of local conditions in policy implementation, concepts, tools and methods, and stakeholders' opinion, like in this study, can provide a basis for the development of guidelines to operationalise ecosystem services, which is highly demanded by the scientific and management communities.

The five case studies analysed here do not represent all EU river basins. However, they provide relevant insights across EU, being probably representative of their national/regional situations, and covering different climatic and socio-economic gradient in the EU. Therefore, the results and recommendations presented here might be relevant for other river basins in the EU and provide a feedback on the actual and potential use of ecosystem service concepts and methods in the implementation of the EU water policy.

Acknowledgements

This research was funded by the European Union EU FP7 project OpenNESS (Grant agreement no. 308428). The authors thank all the members of the Case Advisory Groups and other contacted stakeholders of the five case studies for their active participation and contribution to the research. CENSE is financed through the Strategic Project UID/AMB/040085/2013 from 'Fundação para a Ciência e Tecnologia', Portugal.

Appendix A. Supplementary data

Supplementary data associated with this article can be found, in the online version, at http://dx.doi.org/10.1016/j.envsci.2016.09.006.

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