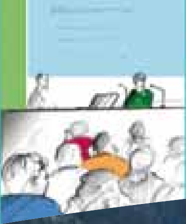
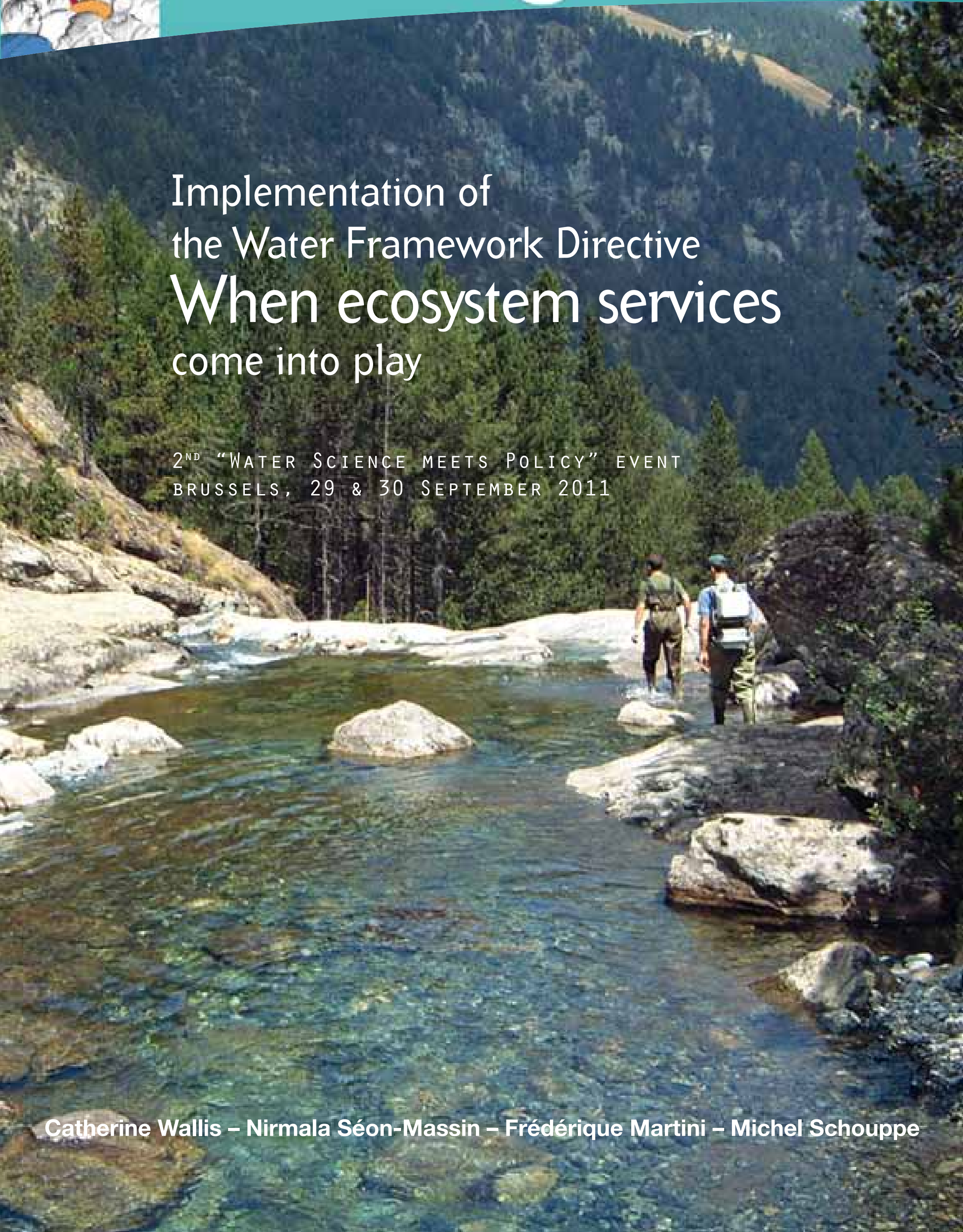


ONEMA **Meeting**

Recap



Implementation of the Water Framework Directive When ecosystem services come into play

2nd "Water Science meets Policy" event
Brussels, 29 & 30 September 2011

Catherine Wallis – Nirmala Séon-Massin – Frédérique Martini – Michel Schouppe

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When ecosystem services come into play

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Catherine Wallis (Asconit Consultants), Nirmala Séon-Massin (Onema),
Frédérique Martini (Onema), Michel Schouppe (European Commission DG R&I)

The 2nd "Water Science meets Policy" event "Implementation of the Water Framework Directive: when ecosystem services come into play", organized by Onema and DG R&I of the European Commission, with the help of a scientific committee of European experts and the support of the International Office for Water, took place in September 29-30, 2011.
This event was labellised "6th World Water Forum".

This publication is available on both Onema's (http://www.onema.fr/IMG/EV/cat7a-thematic-issues.html#meetings) and Asconit's (www.asconit-communication.com) websites. It has also been referenced in the national database "les documents techniques sur l'eau" (www.documentation.eaufrance.fr).

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Foreword

The ad hoc activity on Water Science Policy Interface (SPI) of the Common Implementation Strategy of the Water Framework Directive (WFD), co-led by European Commission DG R&I and Onema, was adopted at the Water Directors meeting in November 2009. It was set up to ensure a cooperative interface between water research and water policy-makers, managers and stakeholders at both EU and national level. Within this framework, “Water science meets policy” events are planned to take place every year. During the first Water science meets policy event on 30 September 2010, the role of ecosystem services was identified as an outstanding cross-cutting issue for the implementation of the WFD and was thus proposed as the theme of the 2011 SPI event.

In the last 5 years, the concept of ecosystem services has gained popularity and has received growing attention as reflected in a number of recent international conventions and policies (Intergovernmental Platform on Biodiversity and Ecosystem Services, Convention on Biological Diversity). Though not explicitly mentioned in the WFD, ecosystem services appear as a promising concept to help its implementation. The WFD requires a change of positioning from water managers: from a management essentially targeting the availability of water with good chemical quality, to the more ambitious goal of ensuring good ecological quality of the natural environments. Already used by some managers and decision makers as a powerful tool for building and implementing programs of measures, this concept is based upon the assumption that there is a connexion between good ecological status and the provision of several benefits, such as water supply, food supply, biodiversity, landscape value etc., collectively called “ecosystem services”.

Approaches using ecosystem services could therefore potentially support WFD objectives. But how much do we understand on ecosystem functioning and its links with both ecological status (sensu WFD) and ecosystem services? What are the potential pitfalls of an ecosystem services approach? What methods are appropriate to value ecological services? Can we use the ecosystem services concept as an educational approach to demonstrate the interdependence of nature and human societies?

The 2011 event gathered over 110 scientists, front-runner policy makers and those who “bridge” the two communities from close to 20 European countries in order to build a common view on the links between the ecosystem services concept and the WFD. It explored how the ecosystem services approach can help highlight benefits (social, economical, environmental) from the WFD and boost political levers for the implementation of the WFD.

This SPI event brought the following outcomes:

➡ clarification of ecosystem services concepts in light of the WFD implementation and first steps towards a common language among scientists and forefront stakeholders at EU, national and river basin levels;

➡ recommendations on how ecosystem services can be used and valued, for integrated watershed management as well as for WFD implementation based on a collection of tangible examples in Europe;

➡ identification of research gaps for further understanding of ecosystem services in the context of the WFD.

Early implication of CIS working groups during the event preparation helped ensuring that policy and management needs were met and priority issues were addressed. This shared overview of an ecosystem services approach for WFD implementation will lay the basis of a more global diffusion in 2012, coined the Year of

Water by many. The SPI event also contributed to the upcoming 2012 Blueprint to safeguard European waters, which aims to assess the first round of RBMPs, review water challenges[1] and provide guidelines for European water policy for the coming 30 years.

This report is structured in three main parts:

➡ the first one introduces the ecosystem services concept and looks at methodologies for applying the ecosystem services approach in integrated water management in Europe, summarizes recommendations for policy makers and remaining research gaps;

➡ the second one summarizes the presentations given during the event;

➡ the third one consists of a glossary, some references, event programme and the list of participants.

The aims of the 2nd Water Science Meets Policy event have been identified as directly relevant to the 6th World Water Forum priorities, in particular Priority for Action 2.4 (Promote Green Growth and Value Ecosystem Services) and Condition for Success CS3 (Enabling Environments through greater Science Policy Interfaces). The outcome of the event has been shared notably with the European Commission for consideration in view of the forthcoming Horizon 2020 Framework programme for EU research and innovation, and with the partner countries of the Joint Programming Initiative “Water challenges for a changing world” in view of their elaboration of a strategic research agenda in the field of water.

[1] Challenges include: diffuse pollution from agriculture, hydromorphological alterations/degradation, chemical pollution, eutrophication, over-abstraction, water scarcity and droughts, and climate change adaptation.

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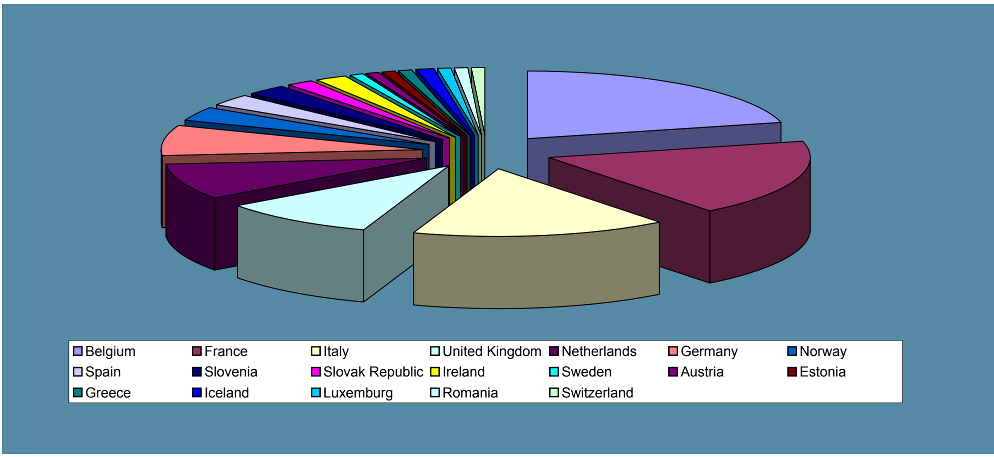
Executive Summary

The 2nd SPI event co-organised by Onema and DG R&I in Brussels on 29-30 September 2011 attracted more than 110 participants from 19 countries (see figure 1). This event was a good opportunity for dialogue between policy makers (42 %), scientists (34 %), water managers (11 %) and representatives of the private sector (13 %).

The event was organised in two main sessions: Session 1 aimed to present and clarify the concept of the ecosystem services approach (ESA) and to showcase their relevance and limitations in relation to the WFD; Session 2 consisted of a series of presentations and of three roundtables to discuss specific case studies where the ecosystem services approach had been tested in relation to three management issues: water quantity, water quality and hydormorphology.

The event helped identify existing knowledge on the ecosystem services concept, existing case studies and

Figure 1. Countries represented at the 2nd SPI event



other tools available for water managers for implementing the ecosystem services approach. It allowed identifying the knowledge gaps to investigate in priority to facilitate WFD implementation in practice.

And finally this workshop allowed drawing some recommendations for follow-up activities aiming to facilitate ESA use in implementing the WFD.

1 – Event findings and available tools

A better understanding of the ESA relevant for aquatic ecosystems

Ecosystem services are usually defined as benefits which humans derive from ecosystems. An ecosystem services assessment is usually carried out in response to a given policy-making process: it is used as an appraisal tool with the aim of highlighting the value of ecosystems at a given scale and analysing trade-offs in natural resources management and land-use choices. Sustaining ecosystem services flows requires a good understanding of how ecosystems function and provide services, and how they are likely to be affected by various pressures. Aquatic ecosystems support a number of key regulatory functions.

Flood plains regulate the water regime (storage during floods and release during low water levels). They regulate the distribution of water in time (flood risk prevention), the scale of runoff and aquifer and water body recharge. The preservation and restoration of river dynamics which promotes (amongst others) the maintenance of aquatic corridors and biodiversity, help reduce flood risks in vulnerable zones. The capacity of aquatic systems and wetlands to provide supporting services (such as soil formation, nutrient cycles, photosynthesis, water cycle) is often degraded due to hydromorphological alterations which alter river dynamics and the correct functioning of the aquatic ecosystem.

Ecosystem services are also an intuitive way for people to relate to ecosystems. Furthermore, ecosystem services help us recognise all stakeholders likely to be affected by decisions, and therefore those who should be included in the deliberative process. This in turn can facilitate more effective communication and engagement with people in socially meaningful terms.

Operational case studies: concrete examples of ESA implementation

Operational examples

A number of projects presented have sought to model the links between ecological processes, good ecological status and the provision of ecosystem services:

- a study implemented by TU Berlin and financed by the German Federal Agency for Nature Protection (BfN) appraised different options for flood protection measures integrating an ecosystem services approach into a Cost Benefit Analysis;
- the JRC undertook an assessment of the contribution of river networks to purifying water through the removal of excess nitrogen from runoff water in Europe;
- a number of case studies showed that hydropower, which may be considered for some aspects as a service from the environment, has a number of direct impacts on hydrosystems including abiotic alteration, physical alteration, and changes in aquatic species composition, in turn undermining other ecosystem services;
- the development of ecosystem services maps and models such as those developed under the UK 2011 National Ecosystem Assessment process can help estimate where ecosystem services are produced, quantify the changes in service provision over time, and describe the production of ecosystem services as a function of patterns of land use, climate and environmental variation.

Assessment methods and valuation: a state of the art

Most of the ecosystem services associated with the water environment can now be valued, and these values vary across locations. Policy makers need to embrace a systemic view of ecosystem services and in this regard need to rely on mapping tools. An ecosystem services approach helps the prioritisation of financial resources for integrated water management programmes. This improves the efficiency of resource use (vital in times of austerity). The number of economic valuation case studies presented provided methods for evaluating changes in flood protection, wetland biodiversity, nutrient retention and river water quality. A number of methodologies also exist to assess cultural ecosystem services (travel costs, hedonic pricing and contingent valuation methods) and have been tested in the TEEB study. A major challenge is how to account for future generations as well as non-use values, which are difficult to estimate in monetary terms. Alternatives to cost benefits assessments were also presented; they include the Nature Value Indicator developed by the PBL Netherlands Environmental Assessment Agency and Multiple Criteria Analyses.

2 – Research and knowledge gaps

Research in aquatic ecology

Further research on river functioning processes

There is a need to develop further research, in particular on the links between geomorphological components, good ecological status and ecosystem functioning, with both preservation and restoration perspectives.

Knowledge provision on the impact of multiple drivers

Research is also needed to provide knowledge on the impact of multiple drivers including land use change on structural and functional capacity of aquatic ecosystems (such as biodiversity and tipping points) and on the impacts on quality and provision of different ecosystem services.

Research in social sciences and economy

Research gaps remain regarding valuation methods including how to deal with the "long" water cycle challenge, to define the right "ecological entity", to consider the supply and demand sides of ecological services, to differentiate primary versus secondary ecosystem services, to account for future generations and and to include ecosystem services valuation into environmental project management.

More socio-political research is required to translate knowledge into evidence and operational tools for policy-makers. This includes "retrofitting" existing tools such as cost benefit analysis; and environmental impact assessments. It would help also to have more global indicators such as the water footprint.

Scale issues: a cross-cutting research theme

Scale issues were also addressed in several aspects: any ecosystem assessment should be bounded by spatial and temporal scales that are appropriate to the objectives of local policy makers and natural resource managers. It may therefore be helpful to widen the usual geographic scope of aquatic ecosystem to encompass physical, biological and socio-economic components of the aquatic environment. Different types of ecosystem services are valued differently as the spatial scale of the analysis varies. Research is still needed to develop valuation tools which integrate values at different scales.

Knowledge management and dissemination

Additional and more diverse ecosystem services assessment case studies

These are needed in order to develop operational tools for better planning and assessment frameworks which break out from silos, provide practical methods for valuation and create conditions for public awareness, better participation and decision-making.

Further knowledge management efforts

These are needed to compile existing experiences and generate lessons learned on water related ecosystem services gained from the numerous INTERREG and LIFE projects on flood management, integrated river basin management, river floodplain restoration, and other water quality improvement projects.

Environmental education programmes

In the same way as climate change adaptation and biodiversity have acknowledged a great deal of awareness raising the past years (e.g. 2010 was the year of Biodiversity), it may be useful to plan environmental education programmes and awareness raising tools on aquatic ecosystem services and their importance for human well-being.

3 – Context and policy recommendations

European context

Following the Convention on Biological Diversity (CBD) and the 2010 Aichi targets, European and national strategies for biodiversity are embracing the concept of ecosystem services and setting targets to halt the degradation of their provision (EU Biodiversity Strategy and global Strategic Plan for Biodiversity 2011-2020). Furthermore, the 2012 Blueprint to Safeguard Europe's Waters will provide an overview of the state of ecosystems and their capacity to supply services. Measures being looked at include indicative targets based on the maximisation of net social benefits from water use. Ecosystem services feature in the roadmap and the EU Biodiversity Strategy whereby ecosystem services will be mapped (by 2014) and valued (by 2020) by each Member State. A biodiversity financing facility is also being set up with the European Investment Bank, public and private partners.

First steps towards using ESA for WFD implementation

The ESA promises to bring a number of opportunities for WFD implementation. It is for instance expected to provide responses on the WFD-economics requirements, the issue of exemptions justification and support the evaluation of the 1st RBMP round. The preparation for the 2012 Blueprint to Safeguard Europe's Waters has shown that the ecosystem services approach can be useful at different stages of the WFD implementation (analysis of water bodies' status and main pressures; definition of legal measures; and during the implementation stage where ecosystem services can provide insights for ecological engineering, decision-making and participation).

In terms of relevance for natural resources management policy, ecosystem services assessments help maximise the range of public benefits potentially stemming from the ways in which we use land, apply technological solutions, direct subsidies and undertake other management interventions. Nevertheless it is important to highlight that the concept of ecosystem services, although developed a few decades ago, is still a relatively new concept especially amongst water policy makers and managers.

However the risks of adopting the ESA is that given ecosystem services are promoted independently of the whole ecosystem for the purposes of justifying selective policies and land use choices. ESA is perceived as a "linking concept" between nature protection, water management, energy and other sectors. It can also act as a focal point for linking different environmental policies such as the Marine Strategy Framework Directive, the Floods Directive, the Nitrates Directive and the Water Framework

Directive add the Birds and Habitats Directives as their articulation with WFD has been identified as an important issue within the “ Natura 2000 biogeographic ” workshops at EU level.

The workshop highlighted the fact that the current state of the art of the ecosystem services approach does not allow to deliver at this stage some simple and concrete guidelines for an operational use by water managers in particular. However the numerous experiences presented at this occasion pave the way for a follow-up activity aiming at making the concept of ESA more operational.

4 – Proposals for follow-up

The event's topic generated much interest from the participants, regardless of their previous level of knowledge on ecosystems services. From the feedback provided by the participants of the workshop, there is a need for developing guidelines on ecosystem services application to the WFD implementation aimed at strengthening knowledge and understanding of ecosystem services and their valuation.

One of the possibilities would be to set up a temporary activity within the Common Implementation Strategy (CIS) to develop operational guidelines for ESA and to promote their implementation in the second river basin management plans (RBMPs). Linked to the WFD implementation challenges, including economical expertise and environmental costs issues, this activity would gather experts both from science and policy backgrounds in order to elaborate some general guidelines and examples of good practices of ESA, and an assessment of information gaps and identification of future tasks for development of more detailed technical recommendations.

This work could be timely linked to the Blueprint to Safeguard Europe's Waters with a view to delivering inputs to it and its follow-up.

This work would consist of:

- ➡ undertaking a review of existing knowledge and state of the art for ESA implementation;
- ➡ evaluating the applicability of the concept for WFD implementation;
- ➡ recommending some good practices for ESA implementation;
- ➡ supporting implementation of these guidelines in the second river basin management plans (RBMPs).

Any follow-up activity should also link up with the work of the EU Biodiversity Strategy Common Implementation Framework (CIF) which is tasked with developing tools for ecosystem services mapping and assessment. ■

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Part I

From concepts to implementation

1 Ecosystem Services concepts

and water management

1.1 – Concept development

The concept of "ecosystem services" has progressed significantly in recent decades. Conceived primarily as a communication tool in the late 1970s to explain societal dependence on nature, it now incorporates economic values as well as other values of biodiversity[2], and supports participatory decision-making for sustainable development. The founding work conducted by Costanza and Daly (Costanza, R. & HE. Daly, 1987 "Toward an ecological economics", Ecological Modelling, vol. 38, September.) in the late 1980s was the first attempt to conduct a large scale valuation of ecosystem services. Following this work, many case studies have highlighted knowledge gaps for valuing natural capital when it comes to land use planning and resources allocation which most likely result in degradation and destruction of this natural capital and eventually prove very costly for society.

The Millennium Ecosystem Assessment (MA) launched by the United Nations in 2001 was the first world implementation programme of the Ecosystem Services Approach (ESA). The objective of the MA was to widen the use of ESA and to highlight, at various territorial scales, the importance of ecosystems and biodiversity protection to maintain economic activity and human wellbeing. It aimed at providing strong scientific understanding of how ecosystems affect human

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[2] As mentioned in the Preamble of the Convention on Biological Diversity. See, for example, Chapter 4: Integrating ecosystem and biodiversity values into policy assessment of the report TEEB (2009).

welfare and how they can be sustainably managed.
The methodology consisted, firstly, in identifying services rendered by ecosystems, and secondly in quantifying those ecosystem services in order to assess their contribution to human well-being. Such an approach justifies the protection of ecosystems as it responds to the needs of human beings and future generations. It assumes that quantifying ecosystem services and their contribution to welfare will eventually lead public and private decision-makers to consider their protection when setting policy and action priorities. Despite the limitations of the exercise and the difficulties encountered in integrating the knowledge of ecologists, ecosystem approaches have significant popularity and are increasingly being applied, especially in developing countries.

Research into ecosystem services has flourished considerably since the publication of the MA in 2005. The Economics of Ecosystems and Biodiversity (TEEB)


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estimated the economic benefits of ecosystems to human welfare and the economic cost to society of ecosystem decline. The TEEB project implements the ecosystem services approach of the CBD (Convention on Biological Diversity, see figure 2), which is a holistic approach covering all different values of biodiversity such as non-monetary values and non-use values which would not classically be included in the Total Economic Value (TEV) approach[3]. Its results were presented at the 2010 Nagoya CBD conference and highlighted a new stepping stone towards understanding the impacts of biodiversity loss on human well-being. The report put forward recommendations such as ending environmentally harmful subsidies and creating "markets" for ecosystem services.

The ESA is used quite widely when talking about biodiversity, but regarding water this is happening only slowly (mainly in the USA, but very little in Europe, and almost not at all so far regarding the implementation of WFD economic requirements). Nevertheless, related ecosystem services concepts have already been used on several occasions[4]. As such the concept is still very much debated amongst scientists with different schools of thought on definitions and classification of ecosystem services. The following paragraph provides an overview of the TEEB and MA definitions.

Figure 2. Identity of the Convention on Biological Diversity, Nagoya 2010

[3] See Chapter 4: Integrating ecosystem and biodiversity values into policy assessment, TEEB, 2009 ebd. ; also p. 35 in ´Chapter 2, TEEB, 2010a.
[4] In France for instance, ONEMA published a report on the topic of ecosystem services (Amigues et al., 2011). The document includes a section on how, although the concept of ES is not named, similar approaches have been developed in integrated watershed management procedures such as SDAGE (RBMP) their local watershed implementation tools (SAGE or river contracts). Another example can be found in a brochure developed by the Agence de l'Eau Rhone Méditerranée & Corse (see web bibliography).

1.2 – Definition of Ecosystem Services and their classification

Assessing ecosystem services generally focuses on the linkages between ecosystems and human well-being, in particular "ecosystem services" which are "flows of value to human societies as a result of the state and quantity of natural capital". Ecosystem services fall into the following generally accepted categories:

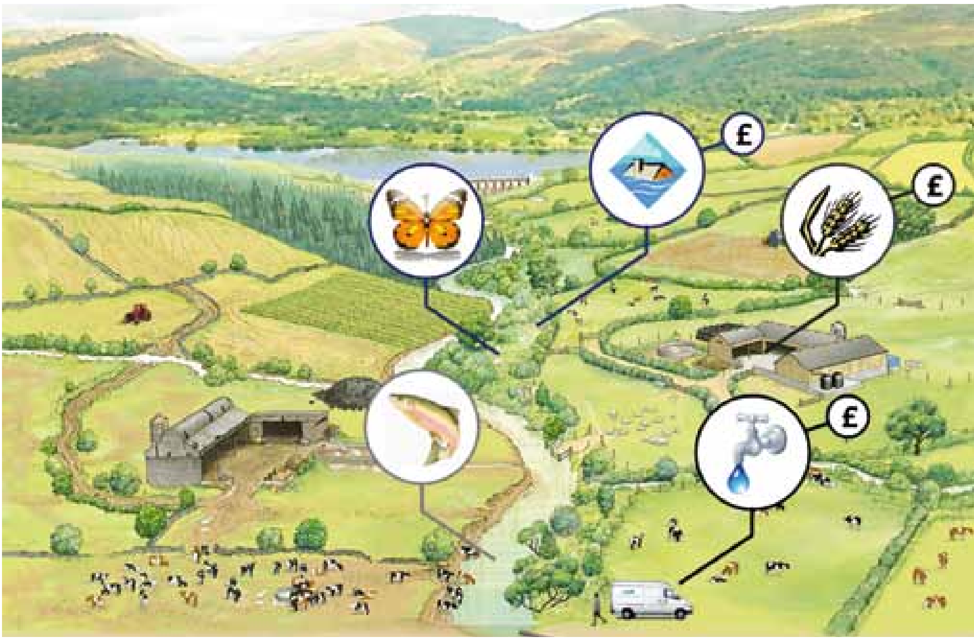
- **provisioning services** are ecosystem services that describe the material outputs from ecosystems such as food, fresh water, raw materials (timber and fibre) and medicinal resources;
- **regulating services** are the services that ecosystems provide by acting as regulators such as the local climate and air quality regulation, carbon sequestration and storage, buffering of extreme events, waste-water treatment, erosion prevention and maintenance of soil fertility, pollination, biological control;
- **cultural services** include non-material benefits people obtain from contact with ecosystems such as recreation and mental and physical health, tourism, aesthetic appreciation and inspiration for culture, art and design, spiritual experience and sense of peace;
- **supporting services** underpin almost all other services and include habitat for species and maintenance of genetic diversity (see table 1 and figure 3).

In addition, some authors (Amigues et al.,2011) differentiate environmental services from ecological services. The former include services which originate from the physical structure (minerals, transportation) but are not dependent on biological processes; the latter imply that biological processes are functional. Another distinction can be made between ecological services – which accounts only as natural capital– and "benefits derived from ecosystems" – which include human investments to benefit from these services (e.g. hydro-electric power).

Table 1. Some ecosystem services identified during studies in river basins (Van der Meulen et al., 2008)

Provisioning	Regulating	Cultural	Supporting
Food and goods	Nutrient removal	Recreation	Habitat
Biomass for renewable energy	Temperature regulation	Aesthetic values	Biodiversity
Water supply	Carbon sequestration	Educational services	
Fish production	Flood protection		
Fibre and fuel	Groundwater recharge		
Hydroelectric power	Pollution control		
Transportation	Soil formation		
	Pollination		
	Nutrient cycling		

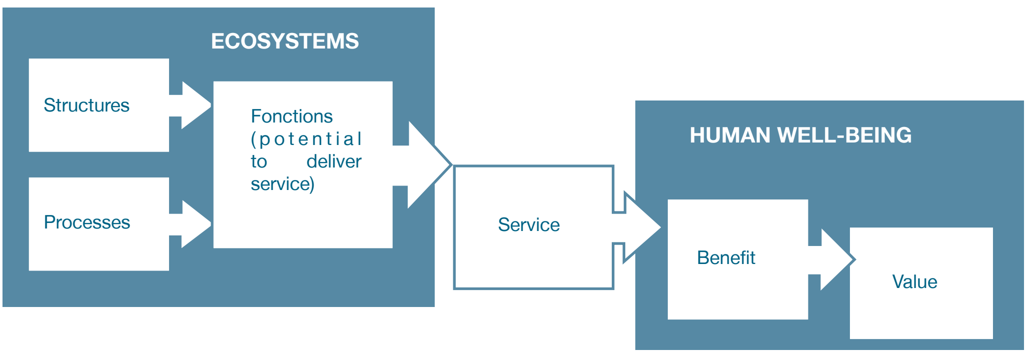
Figure 3. A schematic diagram showing a farm on the left which is dominated by the ecosystem Service of food production at the expense of other services whilst the farm on the right produces food and many other ecosystem services. The Rivers Trust is developing new markets for alternative Ecosystem Services to move farms from left to right
(source: the Westcountry Rivers Trust)



From an economic point of view, the flows of ecosystem services can be seen as the “dividend” that society receives from natural capital. Maintaining stocks of natural capital allow the sustained provision of future flows of ecosystem services, and thereby help to ensure enduring human well-being (TEEB 2010a). Sustaining these flows also requires a good understanding of how ecosystems function and provide services, and how they are likely to be affected by various pressures. Insights from the natural sciences are essential to understanding the links between biodiversity and the supply of ecosystem services, including ecosystem resilience – i.e. their capacity to continue to provide services under changing conditions, notably climate change.

Furthermore, ecosystem services are generated by ecosystem functions which are underpinned by biophysical structures and processes (de Groot et al., 2009). Figure 4 illustrates the linkages between ecosystem structures, processes, functions and services. This representation conveys the message that external pressures (drivers) affecting ecosystem integrity can have an impact on the provision of ecosystem services.

Figure 4. The ecosystem services cascade (adapted from Haines-Young and Potchin, 2010)



1.3 – Ecosystem Services Approach

The ecosystem services approach adopted by the MA examined how changes in ecosystem services influence human well-being. Human well-being is assumed to have multiple constituents, such as enough food at all times, shelter, clothing, and access to goods, health, good social relations, personal safety, and security from natural and human-made disasters; and freedom of choice and action.

Even though the conceptual framework for the MA makes a distinction between men and society on the one side and ecosystems on the other, it assumes that people are integral parts of ecosystems and that a dynamic interaction exists between them and other parts of ecosystems, with the changing human condition driving, both directly and indirectly, changes in ecosystems and thereby causing changes in human well-being.

The ecosystem services approach consists of the following steps (TEEB 2010b):

➡ **identification** of human activities on ecosystems ("recognising value");

➡ **quantification** of ecosystem services ("demonstrating value") – this step does not necessarily imply providing monetary values but using indicators of the state/scope of those services;

➡ **integration** of results into natural resource management decisions ("capturing value").

However it should be noted that the ecosystem services approach does not directly assess ecosystem integrity (how well ecosystems function). For this, a specific analysis of the different ecosystem functions is required, which is likely to include aggregated indicators such as "good ecological status".

Ecosystem scale

Operationally, the geographic and time scale of entity to be assessed need to be defined in a way that results are relevant to the issues at stake by end-users of the Ecosystem Services Approach results. Central to the ESA is the recognition that any ecosystem assessment should be bounded by spatial and temporal scales that are appropriate to the objectives. Boundaries for management will be defined operationally by users, managers, scientists and local people. It may therefore be helpful to widen the usual geographic scope of aquatic ecosystem to encompass physical, biological and socio-economic components of the aquatic environment.

Global pressures at large spatial scales such as climate change, source populations and the effect of discharge changes on sediments and channel dynamics affect the local ecological status and may even constrain the effect of local restoration measures. These wider scale issues are rarely considered in RBMPs. The IMPACT project, funded by IWRM-Net (see web bibliography), is currently analysing the relative importance of anthropogenic pressures operating at different spatial scales for the ecological status of restored or near-natural reaches. The project will do this by coupling physical and biological models such as:

➡ catchment rainfall/runoff models to predict discharge, nutrient, and sediment load;

➡ morphodynamic models to assess changes of channel form and dynamics;

➡ habitat models to describe fish and invertebrate assemblages that can be expected in the reach given the modelled abiotic conditions.

1.4 – Integration of an ecosystem services approach in European public policies

More and more environmental policies are referring to the need to adopt an ecosystem services approach for assessing the best management strategies and land use choices. The strong criticism of the traditional "silo approach" observed in natural resource sector strategies is gradually providing more legitimacy for adopting a more systemic approach to environmental management. Water managers for instance may in the future be tasked with reporting on the identification, characterisation and evaluation of ecosystem services. This will require them to mobilise a range of tools from disciplines such as ecology, economics, legislation, sociology and politics. ESA is perceived as a linking concept between nature protection, water management, energy and other environmental sectors. It can also act as a focal point for linking different policies such as the Marine Strategy Framework Directive, the Floods Directive and the Water Framework Directive. This section provides a brief overview of these policies in relation to ecosystem services.

Water Framework Directive and 2012 Blueprint to Safeguard Europe's Waters

The concept of ecosystem services does not feature in the Water Framework Directive as such, however there is an implicit link between evaluation of ecosystems services and achieving WFD objectives namely "reaching good ecological status [GES] for all surface water bodies by 2015". This link is best understood through the economic requirements of the WFD.

The ESA promises to bring a number of opportunities for WFD implementation. Firstly, it is expected to provide responses on the WFD-economics requirements, the issue of exemptions justification and support the 1st RBMP evaluation round. At the strategic level (river basin scale) it could be used for balancing policies and selecting between policy options; at the local (water body) it can help unravel specific situations in "hot spots" with societal conflicts or high ecological threats.

The Water Framework Directive (WFD) requires the preparation of economic assessments in order to inform management policies[5]. A number of WFD articles refer to valuation of ecosystem services, namely:

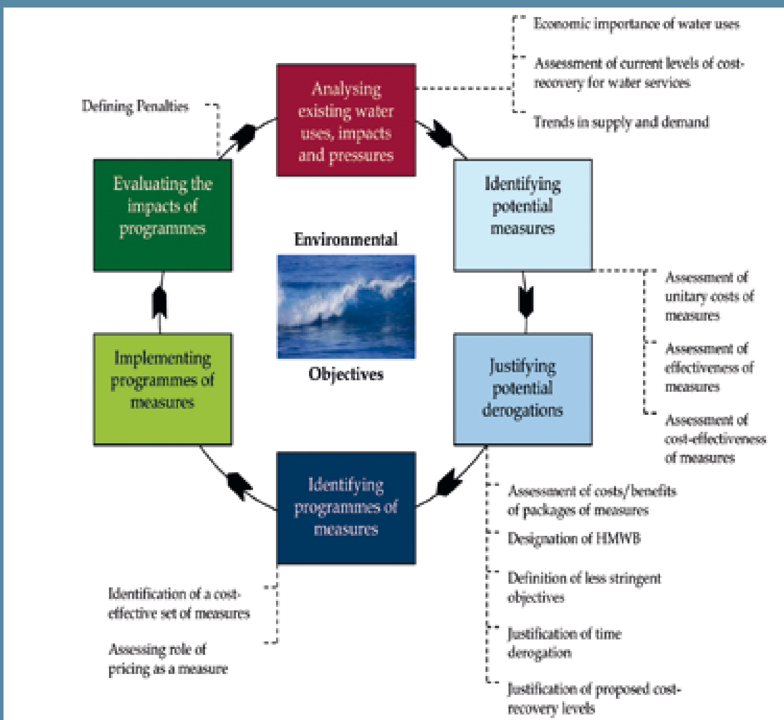
➡ article 5. assessment of the economic significance of water use and current level of cost recovery (baseline assessment)

[5] The 2002 WATECO CIS guidance calls for a thorough integration of economic elements to facilitate decision-making.

- ➡ article 4. decisions on derogations based on disproportionate costs (time derogations, less stringent objectives, designation of heavily modified water bodies);
- ➡ article 9. assessment of the level of cost recovery and incentive pricing;
- ➡ article 11. selection of the most cost-effective sets of measures for achieving good ecological status/potential for the Programmes of Measures (see figure 5).

Environmental and resource costs[6] play a central role in the economic analysis of the WFD. Foregone

Figure 5. WFD steps and economic requirements
(Source: Common Implementation Strategy for the Water Framework Directive, Guidance document n° 1 Economics and the environment, the implementation challenge of the Water Framework Directive)



ecosystem services, (i.e. ES that no longer exist), should be considered as part of environmental and resource costs (although only considering foregone services neglects benefits beyond meeting WFD goals).

The WFD is very much directed at selecting the most cost-effective sets of measures in terms of reaching its goals. In order to assess whether costs to achieve GES are disproportionate or not, one needs to compare the costs of the Programme of Measures with the benefits of achieving GES. Traditionally this is done through a cost benefit analysis and thus requires valuing environmental benefits, but methods to value benefits still require technical improvements (substitute effects, scale, spatial heterogeneity of preferences, etc).

Since the adoption of the Water Framework Directive in 2000, EU water policy has made another step change by taking an integrated approach on the basis of the concept of river basin management aimed at achieving good status of all EU waters by 2015. However, as pointed out by the European Environment Agency's 2010 State of the Environment Report, the achievement of EU water policy goals appears far from certain due to a number of old and emerging challenges. The Blueprint to Safeguard Europe's Waters will be the EU policy response to these challenges. It will aim to ensure good quality water in sufficient quantities for all sustainable and equitable uses.
The Blueprint will provide an overview of the state of ecosystems and their capacity to supply services. Measures being looked at include indicative targets based on the maximisation of net social benefits from water use. Ecosystem services approach is a relevant policy instrument: it provides a link between ecological status and services. Ecosystem services need to be better integrated into cost benefit analysis, into water

[6] See glossary of terms for the definition of environmental costs

pricing in cost recovery and to assess agricultural measures. Ecosystem services can also be taken into account for setting targets for water resources protection at the river basin level.

Marine Strategy Framework Directive

Article 1.3 of the European Commission's 2008 Marine Strategy Framework Directive (MSFD) states that: *"Marine strategies shall apply an ecosystem-based approach*[7] *to the management of human activities, ensuring that the collective pressure of such activities is kept within levels compatible with the achievement of good environmental status and that the capacity of marine ecosystems to respond to human-induced changes is not compromised, while enabling the sustainable use of marine goods and services by present and future generations".* While it does not specifically refer to ecosystem services, the approach requires an understanding of the way in which society manages the exploitation of nature thus assessing the benefits rendered by ecosystem services.

Floods Directive

The ESA helps us recognize the relationships between stocks of natural capital, such as land and water, and the services that they provide to support human prosperity and wellbeing. Floods are a naturally occurring phenomenon which is essential to the functioning of aquatic ecosystems (hydrological processes) and biodiversity of natural habitats (soil formation on the banks). However, they can potentially have harmful impacts on human lives and activities which depend on a number of ecosystem services (alteration of drinking water sources, loss of infrastructure and economic activities such as farming).
The Floods Directive calls for establishing flood hazard maps and flood risk maps

[7] See glossary of terms for the definition of ecosystem-based approach.

showing the potential adverse consequences associated with different flood scenarios on human health, the environment, cultural heritage and economic activity thus including impacts on the provision of ecosystem services and their degradation (e.g. environmental pollution).

Nitrates Directive, Common Agricultural Policy and Groundwater Directive

The Nitrates Directive (1991) aims to protect water quality across Europe by preventing nitrates from agricultural sources polluting ground and surface waters and by promoting the use of good farming practices. Under the Directive, all Member States have to analyse their waters nitrate concentration levels and trophic state. Good monitoring is crucial, and means setting up high-quality monitoring networks for ground, surface and marine waters. Reducing nitrates is an integral part to achieving the Water Framework Directive objectives.

The Common agricultural policy (CAP) backs up the Nitrates Directive through direct support and rural development measures. For example, several Member States have included nutrient management measures. The Groundwater Directive (2006) states that nitrate concentrations must not exceed the trigger value of 50 mg/l. Several Member States have set their own tighter limits, in order to reach good status.

A number of Payment for Ecosystem Services (PES) schemes operate in several Member States between farmers and water treatment plants to incite farmers to adopt more environmentally friendly approaches and reduce nitrate leaching into water bodies. See Waternet case study in the Netherlands and the River Tamar in south west England presentations in Chapter 5.

The Natura 2000 network and Birds and Habitats Directives

Natura 2000 is the cornerstone of EU Biodiversity Policy. It is a network of more than 25 000 conservation sites all over the EU, and provides extensive socioeconomic benefits. These include direct benefits from tourism and recreational activities, but also ecosystem goods and services such as flood control, de-pollution of water, pollination, and nutrient recycling.

Natura 2000 adopts an ecosystem-based approach whereby harmonious coexistence between humanity and nature is promoted. Economic activities (supplied through the ecosystem) include farming, tourism, fishing, forestry, sustainable hunting, leisure pursuits and infrastructure projects. Member States have to ensure, however, that sites are protected from damaging changes, and managed in line with rules laid down in the Habitats Directive. Participatory approach is given a strong role: local stakeholders should be fully involved, whether they are landowners, businesses, local authorities, community and environmental groups, or individuals.

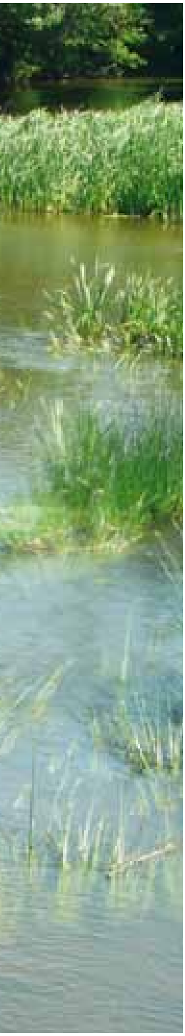
European and International Biodiversity Strategies

The EU Biodiversity Strategy was published in May 2011 and includes the headline target of *"halting the loss of biodiversity and the degradation of ecosystem services in the EU by 2020, and restoring them in-so-far as feasible, while stepping up the EU contribution to averting global biodiversity loss"*. It requires that Member States be able to assess at national level the status of their ecosystems and their associated services in their national territory by 2014, assess the economic value of such services, and promote the integration of these values into accounting and reporting systems at EU and national level by 2020. The JRC has published in 2011 a report on the European status of ecosystem services (figure 6). The global Strategic Plan for Biodiversity 2011-2020 was launched at the Convention on Biological Diversity's tenth Conference of Parties in Nagoya, Japan, in October 2010. The plan contains 20 objectives, known as the Aichi targets, including one target which specifically refers to ecosystem services: *"By 2020 ecosystems that provide essential services, including services related to water, and contribute to health, livelihoods and well-being, are restored and safeguarded, taking into account needs of women, indigenous and local communities"*.

Figure 6. Cover page of the JRC report "A European assessment of the provision of ecosystem services", published in 2011

2 Methodologies for applying

the ecosystem services approach



Chapter 2 provides an overview of the possible applications of the ecosystem services approach in terms of providing a better understanding of ecosystems and their functionning, assessing the value of ecosystem services (through monetary techniques and other approaches) and finally in terms of the use of ESA for water resource policy and management. Chapter 2 is based on lessons and examples from the case studies presented at the 2nd SPI event in Brussels, focusing on methods and results.

The event included three roundtables which focused on three themes namely:

➡ roundtable 1. Ecosystem services, water scarcity management and flood protection

➡ roundtable 2. Ecosystem services, water quality management and diffuse pollution protection

➡ roundtable 3. Ecosystem services, maintaining and restoring good hydromorphological status.

Should the reader prefer to read in more detail about these themes and each case study (including background, rationale and implementation), these are provided in greater length in Part II Contributions to the conference.

2.1 – Better understanding of ecosystems

Good ecological status, ecological processes and functions

Some aquatic ecosystems are, together with tropical forests, the most productive systems on the planet. Maintaining their good status is vital to ensure the continued supply of economic activities and to address basic population needs in terms of food and drinking water (*see Millenium Ecosystem Assessement*).

Most services provided by ecosystems depend on the conservation status of ecosystems. Indeed, "healthy" ecosystems are often required to ensure the preservation of functions and services associated with those ecosystems. The abundance and diversity of ecosystem goods and services are closely dependant on the quality of the environment. Modified aquatic systems or with a degraded functioning (realigned water courses, homogenous habitats, artificialised riverbanks) lead to changes in the ecosystem structure such as disturbed food chains, accelerated eutrophication rates, exacerbated species competition, species confinement.

The ecosystem services approach does not directly assess ecosystem integrity (how well ecosystems function). For this, a specific analysis of the different ecosystem functions is required, which is likely to include aggregated indicators such as "good ecological status". Ecosystem services are an entry point for humans to relate to the importance of the preservation of specific ecological functions and processes.

Good ecological status, as defined by the Water Framework Directive, refers to the status of surface water bodies when both their ecological status and chemical status are ranked at least "good"; and for groundwater bodies when both their quantitative status and chemical status are at least "good". Achieving good status is the paramount objective of the WFD.

A number of projects presented at the 2nd SPI event have sought to model the links between ecological processes, good ecological status and the provision of ecosystem services.

Example 1: Regulation of floods and droughts: water retention capacity

Aquatic systems such as flood plains regulate the water regime (storage during floods and release during low water levels). They regulate the distribution of water in time, the scale of runoff and aquifer and water body recharge. The storage of water in floodplains reduces damages due to flood risks downstream, contribute to water purification in wetlands and aquifer recharge. The preservation and restoration of river dynamics which promotes (amongst others) the maintenance of aquatic corridors and biodiversity, help reduce risks of flood damage in vulnerable zones.

A study implemented by TU Berlin and financed by the German Federal Agency for Nature Protection (BfN[8]) compared the cost and benefits of relocating dikes (to enlarge the river bed) compared with establishing flood polders (specifically designated flood retention areas which can be opened for flooding upon demand) and a combination of the two options as a way to manage the morphology of the river water bodies and therefore increase flood protection. The study undertook the detailed modelling of biophysical effects of the different options and translated them into quantifiable benefits, which could be used in the cost benefit analysis study. The assessment was made possible thanks to the availability of a large scale hydrological flooding model. It showed that the flood

[8] See presentation in Chapter 5 from Volkmar Hartje on Economic valuation of dike relocation in the German Elbe.

protection was greater with the dike relocation option (reduced maximum flow and water height). Additional ecosystem system services such as nutrient retention were also assessed using the MONERIS model. The study however did not include indirect effects of dike relocation and could be further improved by taking into account detailed ecological modelling with vegetation growth and hydromorphological changes.

Example 2: Pollution regulation: auto-purification function of river bodies and the alluvial plain

Continental, coastal and marine aquatic ecosystems provide water purification functions. They absorb and detoxify heavy metals, excess nutrients or pesticides thanks to biological and physical processes in the soil or sub-soil.

Studies have shown that a river with diverse morphological characteristics has an increased purification potential. Morphological parameters include flow, current speed, temperature and geomorphology. Generally speaking, the more the interactions between surface waters and the river bed are diversified, the better the purification potential is. Inversely, heavily modified water courses have a lower potential for purification.

The French Ministry of Ecology estimated at 3 billion euros the annual costs of water pollution in France[9]. It was estimated that the purification function worldwide has an economic value of about 251 €/ha/year (Schuyt et al., 2004). The preservation of water quality through restoration programmes could represent significant cost savings in terms of drinking water treatment and water pollution abatement. Furthermore, if pollution exceeds a certain threshold water is no longer eligible for purification towards drinkability so there is a cost of completely losing a potential drinking water resource.

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[9] According to the French Ministry of Ecology website and quoted in *De la qualité des milieux aquatiques dépendent de nombreux services rendus à la société, Onema, Mai 2010.*

Case study. Denitrification capacity of European river networks

Nitrogen loading in the environment has multiple effects: on the one hand it enhances crop production, coastal fish production and water purification, on the other it can also affect drinking water quality, reduce recreation opportunities and reduce ecological status. This illustrates the different synergies and trade-offs between ecosystem services and ecological status.

The JRC undertook an assessment of the contribution of river networks to purifying water through the removal of excess nitrogen from runoff water in Europe[10]. The mapping methodology is based on a catchment specific nitrogen budget model (GREEN) to assess how much nitrogen is retained by surface waters. Hydrology and geomorphology at the ecosystem scale both affect the proportion of nitrogen removed (see figure 7).

Adopting the Ecosystem services cascade model (Haynes-Young et al., 2010) (see figure 4), the JRC selected variables including river systems (structure), denitrification uptake and sedimentation (as processes) and the potential to remove nitrogen from surface waters (function). The benefit for human well-being is the provision of clean drinking water and recreation which can be valued through different valuation methods. Nitrogen loading (drivers) include emissions from households, traffic, industry and agriculture.

The results of the study show that about 1.5 million tons of nitrogen is removed by rivers per year, which equates to the amount of nitrogen produced through point sources. Rivers and lakes provide at no cost the denitrification service which increases the quality of surface waters.

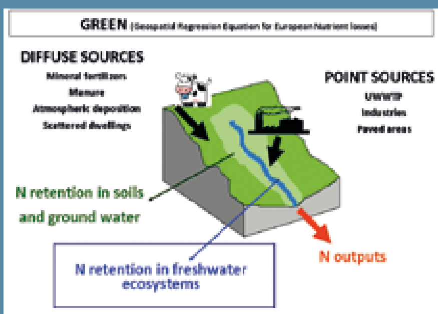

Figure 7. An illustration of the GREEN Model, estimating nitrogen flows in Europe (source: Haynes-Young et al., 2010)

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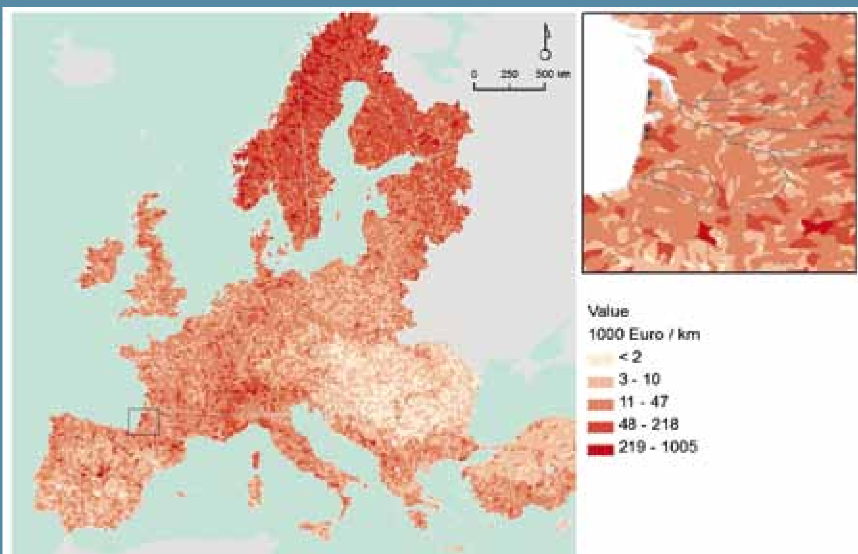
[10] See presentation by Joachim Maes, European Commission – JRC, on Mapping and valuation of water purification services in Europe in Chapter 4.

Spatial analysis, such as the one carried out by the JRC, allows showing where ecosystems gain and loose in terms of delivered services. Denitrification benefits tend to be received in downstream areas whereas economic values are generated in upstream areas (see figure 8). This corroborates the observation that values are often generated elsewhere than the areas where benefits are received. Upstream-downstream linkages are certainly complex, especially at the larger scale, and the information required to understand the interactions has until recently proved difficult and costly to collect. However, the recent rise of dynamic modelling at the basin level coupled with more affordable monitoring tools, such as remote sensing, will provide future watershed management operations with better capability to define upstream-downstream relations, set and monitor targets, and value benefits (World Bank, 2008).

Figure 8. Monetary value of Nitrogen retention showing upstream and downstream variations (source: Joint Research Center)



The biological processes which increase the capacity of river basins to retain nitrogen seem to include: primary production of nitrogen (uptake of nitrogen by macrophytes and algae in riparian wetlands and floodplains) and sedimentation and denitrification. River restoration (e.g. allowing meandering) will increase sedimentary environments for denitrification. The rate of nitrogen removal is higher in ecological quality status water bodies with a poor to moderate ecological status.

Example 3: Role of hydromorphology in river dynamics

The capacity of aquatic systems and wetlands to provide supporting services (such as soil formation, nutrient cycles, photosynthesis, water cycle) is often degraded due to hydromorphological alterations which alter river dynamics and the correct functioning of the aquatic ecosystem. Human development activities have severely affected the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hydromorphology of our water bodies. Hydromorphology alterations are often irreversible, permanent and profound and entail not only short-term and local consequences but can also have repercussions far outside the time and space scales of the pressures that generated them.

Channel and floodplain morphology (including lateral and longitudinal connectivity) and sediment transport regime (including quantity, quality and timing) are considered key geomorphological characteristics necessary to support many of the ecosystem services relied on by human societies[11].

[11] 7th Geomorphololgy and Gravel-bed River Ecosystem Services workshop, Tadoussac, Canada 8th September 2010. For more information see: Bergeron, 2012.

Case study. Hydropower impacts on alpine river ecosystem integrity (SHARE project)

Alpine rivers are often more vulnerable than downstream hydro-systems and often host a wide stock of alpine biodiversity. Hydropower has a number of direct impacts on mountain hydrosystems which includes: alteration of the physico-chemical status (temperature regime, oxygen regime, trophic state), hydromorphology alteration (hydrology, morphology, sediment balance), and changes in aquatic communities. A number of ecosystem services are compromised by and conflict with hydropower production[12].These are: fresh water provisioning, loss of habitat, extreme hydrological events regulation, sediment balance, water purification, recreation, local climate regulation…

The degree of hydropower impacts depend on the specific characteristics of each hydropower plant: a river dam affects all dimensions of a river ecosystem (longitudinal disruption of the river continuum, natural zonation of the habitat change, vertical interruption to the groundwater-river connexion, natural flood water storage limitation) whereas a micro hydropower plant with immediate water restitution appears to have no or little long-lasting effects on rivers[13].

The current WFD ecological quality indicators do not seem to be relevant for measuring hydropower pressures (the metrics are too narrowly focused in size and range of biological indicator species, short investigation periods, etc). Biological indicators such as diatoms, macrophytes, invertebrates and fish are better indicators of the trophic status rather than hydropower impacts.

Hydromorphological indicators hold strategic information to assess hydropower effects on hydrosystems: high hydromorphological diversity is closely linked to a high number of ecosystem services and high biodiversity reservoirs. Hydromorphological indicators are particularly fitted to represent ecosystem services exposed to hydropower exploitation pressures. A number of hydromorphological methods have been developed to assess river morphological status assessment and ecological functionality and are useable at a wider scale (including riparian ecosystem services) compared to other indicators. These indicators can complement WFD biological indicators.

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[12] Some authors consider that hydropower production is an environmental service (as opposed to an ecological service, see glossary for further definitions).
[13] According to Andrea MAMMOLITI MOCHET, event SHARE project presenter from ARPA Valle d'Aosta - Regional Environmental Protection Agency of Aosta Valley (Italy).

Figure 9A - "Grand'Eyvia river - Compagnia Valdostana delle Acque - Aosta Valley region, North West of Italy", (source: ARPA Valle d'Aosta)
Figure 9B - "Evançon river - Aosta Valley region - North West of Italy", ARPA Valle d'Aosta

Case study. Dordogne River and Hydromorphological Good Status

The hydraulic and ecological system of the Dordogne River has been deeply modified due to construction and operation of hydro-electric dams and mineral extraction in the flood plain. Since the beginning of the 1990s, an integrated water management policy was implemented in the Dordogne basin under the governance of a Regional Public Watershed Board (EPIDOR). The pressures on the river morphology are still high and a number of artificial flood protection practices are maintained in spite of their negative impacts on ecosystems.

River dynamics, and particularly the river's capacity of shifting its course naturally, can have a tremendous impact on the Dordogne ecosystem integrity. In the context of reaching WFD good status objectives, most of the downgrading factors in the Dordogne case study depend on the river's physical status. The ESAWADI project (due to finish in 2012) is currently testing the benefits of water management measures aimed at improving the hydromorphological status and thereby convincing the different stakeholders of the relevance of these measures. To date, the project developed an assessment framework based on the relations between river functional compartments, ecosystems and ecosystem services and drafted a questionnaire for understanding how the riparian population related to hydromorphological issues[14].

Quantitative assessment of services

Once the relevant ecosystem services have been identified, the context of the decision will determine which methods and what degree of quantification and monetary valuation is appropriate (TEEB 2010a). Assessing ecosystem services implies the measurement of the contribution of ecosystems to human well-being on the basis of indicators.

Indicators can be based on technical and economical data. For instance, to assess the water purification service of a riffle, an indicator of the effectiveness of the riffle would be the value of the water treatment required

[14] See ESAWADI project for further information.

to give the same service. An indicator of professional fishing service would be the number of fishing authorisations delivered or the quantity of commercial fish species available. An indicator of recreational water sports services would be the number of people practising that particular water sport. Quantification indicators can be expressed in volumes/flows per surface and time (such as tons of NO_3/ha/year) as well as with monetary indicators (euros per hectare per year). Overall, provisioning and regulation services are easier to quantify than supporting and cultural services.

Indicators may also be based on statistical data which, most of the time, are not available at the scale of ecosystems but at the scale of administrative areas (municipalities, counties, regions, national level territory). Quantification may encounter several hurdles: scale issues between available data and ecosystems considered, distinction between ecological services and environmental services, data methodology discrepancies between areas, knowledge gaps. Given these difficulties and uncertainties, it is clear that quantitative assessments should inform debates rather than present exact figures. Quantification work will be an effective decision-making support if it gains legitimacy through the collective appropriation and debate.

The JRC undertook the first mapping of ecosystem services at the European scale[15] (see figure 10). The work comes in support to Action 5 of the new Biodiversity Strategy of DG ENV ("Member states, with the assistance of the Commission, will map and assess the state of ecosystems and their services in their national territory by 2014, assess the economic value of such services, and promote the

[15] See the "European assessment of the provision of Ecosystem Services" report, published in 2011 which presents the first spatially explicit baseline for assessing the state of ecosystem services in Europe.

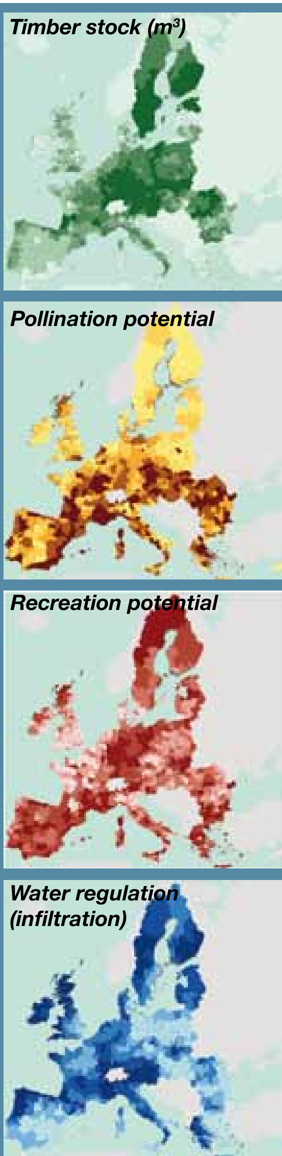

Figure 10. Ecosystem services mapping for timber services (in green), food security services (in yellow), water security services (in blue) and for health and wellbeing (in red), Joint research Centre, European Commission (source: Joint Research Centre, European Commission)

integration of these values into accounting and reporting systems at EU and national level by 2020").

The development of ecosystem services maps and models help estimate where ecosystem services are produced, quantify the changes in service provision over time, and describe the production of ecosystem services as a function of patterns of land use, climate and environmental variation. Importantly, a spatially explicit assessment of ecosystem services can couple biophysical estimates of service provision to an economic and monetary valuation.

The JRC collected spatially explicit indicators for 13 ecosystem services. For each service, they identified indicators for service capacity and service flow, the benefits derived from each service; the biodiversity components that are essential to sustain the generation of these services and the contributing land cover classes using CORINE land cover data. The indicators presented in table 2 were selected to assess and

Table 2. Indicators and variables considered for water security services assessment

Ecosystem service	Indicator	Variables (spatially explicit ecosystem service indicators)
Freshwater provision	Water provision capacity	Share of wetlands and water bodies (surface water flow)
Water quantity regulation	Water regulation capacity Water flow regulated by terrestrial ecosystems	Infiltration Sub surface water flow
Water purification	Water purification capacity Removal of pollutants	Average nitrogen retention Average in-stream nitrogen removal

map different water related ecosystem services.

Using a principal component analysis (PCA), the JRC was also able to assess trade-offs between the mapped ecosystem services (in terms of whether two or several ecosystems services were spatially correlated – positively or negatively – or uncorrelated). For instance, regions with higher lake and wetland density such as Northern Europe and the northern parts of the British Isles are characterised by greater soil functioning (indicated by soil carbon content), water regulation services (infiltration capacity of soil) and erosion control.

The direct application of ecosystem services mapping is the ability to evaluate different scenarios with respect to land use, biodiversity or human inputs against a set of baseline maps in order to detect areas where ecosystem services increase or decrease. Such assessment necessitates the development of a model methodology coupled to a geospatial database as well as of story lines for different scenarios. Possible approaches for ecosystem service model development are currently under consideration.

The JRC methodology addresses a number of scale issues. Indeed, all spatial indicators for ecosystem services differ in spatial resolution and scale. The spatial scale at which pan-European ES indicators can be mapped depends essentially on the mapping resolution of the biophysical models that have been used to derive the indicators. Land related ES such as soil services are commonly available at resolutions of < 1 km, while services related to the atmosphere are usually available at scales > 1km. Water related services are often calculated on the basin or sub basin level. Spatial information for cultural services is generally only available at a provincial level. So whereas individual ecosystem service maps were presented in their original resolution, the spatial unit of a trade-off assessment will be a compromise between the different spatial units in which the indicators can be mapped and more importantly, the spatial resolution at which an economic valuation is still meaningful.

Management of ecological functions

Research as presented above shows that we are gradually gaining a better understanding of ecological processes and functions and links between these and the supply of ecosystem services. Ecological engineering has been defined as the design of ecosystems for the mutual benefit of humans and nature. It is based on structural ecological processes (self-organisation, high diversity, resilience) and integrates economic and social issues. Applications of ecological engineering include the restoration of degraded ecosystems, restoration of functional communities and species reintroduction; the creation of new sustainable ecosystems; and the development of biological tools for pollution control

[16] Source : web site of the Groupe d’Application de l’Ingénierie des Ecosystèmes (Gaié), the French network on ecological engineering.

and to re-establish or optimise ecosystem services provision[18].

The 2nd SPI event provided concrete examples of ecological engineering. These are detailed below.

Example 1: Tree planting to influence water infiltration in north Italy

The TRUST project in Veneto-Friuli basin tested different types of natural sites for artificial aquifer infiltration effectiveness including a forested area, grassland and uncultivated land. The groundwater status modelling tool allows to evaluate for homogeneous hydro-geological areas the effectiveness of different infiltration practices (through artificial Managed Aquifer Recharge) to protect and restore the quantitative groundwater resource. The project undertook geo-electrical surveys in order to assess the infiltration rate of water, infiltration measure campaigns in natural river-beds, on site experimentation of artificial groundwater recharge in irrigated agricultural areas.


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The project found that forested areas promoted greater water infiltration and groundwater recharge, removal of nutrients from water and production of wood biomass compared with cropland at the river basin scale. The annual volume of water recharge over 100 hectares using a forested area infiltration method would be over 50 million m3. Groundwater recharge and woodchip revenue could also be included in a payment for ecosystem services scheme where farmers are compensated for foregoing their usual crops for fast growing woodchip species in exchange for the improved groundwater filtration.

Example 2: Dike relocation in Germany (see also p.39)

In the past, the construction of artificial storage with the inclusion of polders was considered to be more effective from a flood control perspective but did not take into account the additional benefits of dike relocation through ecosystem services. The debate between dike relocation proponents and dike strengthening/controlled storage methods is very topical especially since the 1992 Elbe floods. In the Elbe river case study, it was assessed that dike relocation (thereby permanently enlarging the river bed) entailed higher overall benefits than to establish flood polders, i.e. specially designated flood retention areas which can be opened for flooding upon demand.

Example 3: Land use management scenarios and water quality in the UK

The effects of land use change on water are likely to result from changes in nutrient inputs. The impact on the ecological status of waterways can therefore be modelled in an interactive way by varying land use choices. Based on the UK National Ecosystem Assessment work, drivers of water quality include reducing root crops (potatoes, sugar beets), dairy cows, temporary grasslands, suspended sediment, lower water temperature, higher rainfall and increasing river flows. The understanding of the drivers of water quality are important to understand for addressing WFD requirements, better management of treatment costs and forecasting impacts on water recreation.

Example 4: Fertiliser reduction via Payment for Ecosystem Services in the Netherlands

In the Netherlands, to reduce the level of nitrates and phosphorus leaching into the Amsterdam water reservoirs, the local water board has initiated a collaborative programme with farmers, involving the Agriculture Nature Unions as intermediaries. Farmers are asked by the water board to construct ditches and maintain wet buffer strips along the farm plots. They receive compensation for the cost of works, loss of earning on the strip of foregone land, management and fencing costs. These measures were sought to improve water quality and provide improved habitat for fish and birds.

Example 5: Hydraulic regulation in Alpine rivers

The SHARE project looked at different management alternatives for managing the water level of the Chalamy alpine river by varying the level of water releases by the hydropower dam in order to optimise ecosystem services with hydroelectricity provision. The project includes a total of 13 partners including public administrations, environmental agencies, research centers, NGOs) in 5 countries (Italy, Austria, Slovenia, Germany and France). The project merged scientific tools, local specificities and operational requirements in order to develop Software and online tools implementing a multicriteria approach, to assess different management alternatives concerning river-related issues.

2.2 – Valuation of ecosystem services and WFD

There is considerable interest in placing values on the natural environment and the goods and services it provides. The interest is fuelled by the concern that ecosystem services may be overlooked and undervalued. As a result the stocks of natural assets which generate these flows of environmental services could be irreversibly damaged with consequences for social welfare. The European Environment Agency (EEA) has highlighted the need for ecosystem accounting techniques to analyse the relationship between economic sectors and their reliance and impacts on ecosystem goods and services[17]. Ultimately, this data should feed into policy-making and local management of natural resources.

There are a variety of methods for valuing ecosystem services which include:

- ➡ assessing the impact of environmental change on costs and/or revenues;
- ➡ estimating the demand for environmental goods and services (e.g. willingness to pay surveys);
- ➡ market prices and production function approaches;
- ➡ surveys and focus groups for obtaining non-economic values.

The following section provides an overview of economic valuation case studies presented at the 2nd SPI event. Alternative non-monetary appraisal tools were also presented and feature later in this chapter.

Examples from real case economic valuations

Example 1: Economic valuation of dike relocation in the German Elbe

The case study focuses on the morphological changes of rivers in Germany which have been changed considerably by diking over the last two

[17] For further information see : An experimental framework for ecosystem capital accounting in Europe, EEA Technical report, N° 13/2011.

hundred years. The resulting changes of water quality have not been dealt with systematically in the in the concerned Programmes of Measures under Water Framework Directive, mostly due to cost considerations, with the exception of fish passability. The relocation of dikes constitutes another option to improve the morphological quality of river water bodies as well as a flood protection measure. In the past, the construction of artificial storage with the inclusion of polders were considered to be more effective form a flood control perspective without taking into account the additional benefits of dike relocation in comparison.


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The debate between dike relocation proponents and dike strengthening/controlled storage methods is very topical especially since the 1992 Elbe floods.
Funded by the German federal government, the case study presents a cost-benefit analysis of a dike relocation programme in the German part of the Elbe, between Dresden and Geesthacht, compared with an equivalent construction programme.
In applying a total economic value approach, the study looked at the ecosystem functions and services provided. It compared three options: dike relocation, the creation of polders, and a multifunction land use option such as controlled "ecological flooding".

Three types of ecosystem services were selected for the evaluation:

➡ changes in flood protection (benefits measured through avoided property damages; costs include investment costs, rehabilitation costs, maintenance costs, opportunity costs of agricultural and forestry land);

➡ changes in wetlands biodiversity (used benefit transfer from 28 European studies based on willingness to pay studies near riverine wetlands);

➡ nutrient retention of wetlands (calculations based on replacement costs, using the MONERIS model on nutrient discharge and retention).

The benefits from these changes of ecosystem services as a result of the dike relocation programme were compared to the cost of two alternative programmes. The comparison shows that the dike relocation programme is more economically advantageous than the polder programme if one includes ecosystem services other than flood protection (nutrient retention and biodiversity). Further research is needed to include carbon sequestration and recreation into the valuation.
A scientific lesson of this case study is that the economic valuation allowed the comparison of alternative strategies for flood protection

in a multifunctional manner. It has also enabled taking nature protection objectives into account. Dike relocation can be assessed through an ecosystem services approach. To do so, it was important to quantify the biophysical effects of measures and translating them into benefits. Additional research is needed to include carbon sequestration and recreation into the valuation. This valuation was made possible thanks to the availability of a large scale hydrological flooding model.

In terms of policy lessons, ecosystem services are a convincing and practical concept to structure multifunctional aspects. Dike relocation is an economically worthwhile option to improve the morphological quality of lowland water bodies. The spatially explicit identification of changes within the biophysical realm and land-use changes are important for policy makers. Including uncertainties is critical for the estimates of quantities and values.

Example 2: Putting values on water recreation in the UK

To assess whether the perceived recreational value of rivers changes with water quality, the UK National Ecosystem Assessment team (see figure 11) undertook a household survey in the Leeds/Bradford area to map out where people would go on holiday and related this back to water quality. They also recorded visit frequency and modelled the trade-offs between frequency, visit costs and water quality. This provides an estimate of the value that individuals attribute

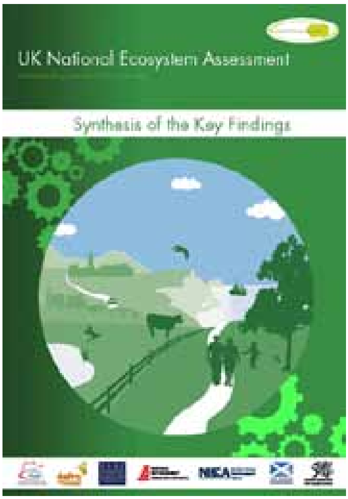


Figure 11. UK National Ecosystem Assessment report

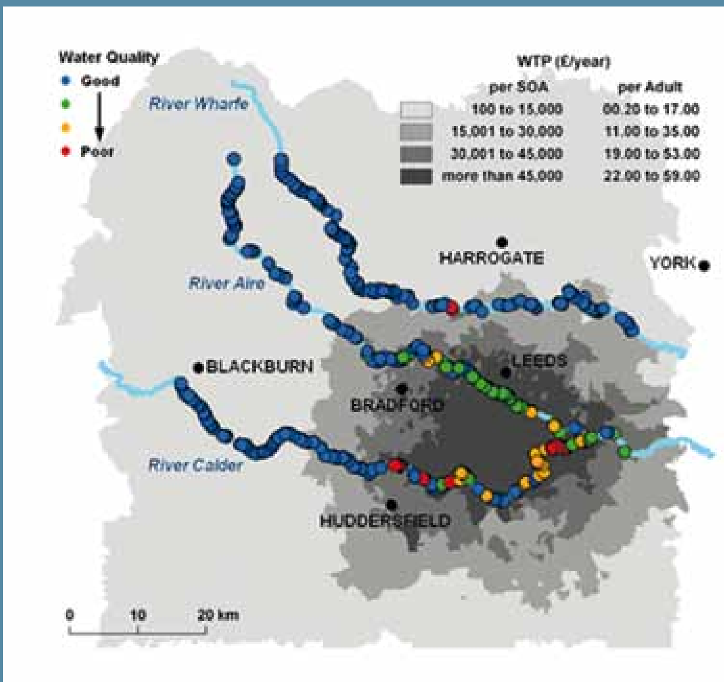
to changes in water quality (contingency valuation).

The results show that people are most likely to visit rivers which are located the nearest to their homes, have a nearby pub, are located far from sewage works, and have high water quality. The willingness to pay for a change in quality ("marginal WTP") is far higher for changes which result in pristine water quality compared to changes which only improved water quality marginally (see figure 12).

Methodological shortcomings with monetary valuations

Numerous methodological issues exist when it comes to economic valuation, coming both from the supply (nature provision of services) and from the demand (users) side. On the supply side, many ecosystem services are not

Figure 12. Willingness to pay survey results for improvement in water quality in Leeds Bradford area. (Source: Ian Bateman, CSERGE, University of East Anglia)



in direct access to the users and the availability of the service depends upon the existence of infrastructure and therefore of the value of the infrastructure and equipment mobilised in providing the service (e.g. hydropower). Ecosystem services which are mainly exploited by society are indeed essentially man-made services (or secondary services) composed of different "primary" provisioning, regulatory and supporting services. Economic evaluations work best for these secondary services and are less robust in assessing primary services.

On the demand side, the demand for ecosystems services is dependent on individual and social behaviour. Most valuation protocols in economics are demand assessments, making use of various methods (stated preferences methods or indirect methods). Another challenge is how to account for future generations as well as non-use values, which are difficult to estimate in monetary terms.

One of the classical economic appraisal tools is Cost–benefit analysis (CBA). It is a powerful instrument, strongly developed methodologically, especially for the evaluation of infrastructure projects. CBA has been awarded an important role in the assessment of integrated land-based development since the 1980s. The analysis of these CBAs shows that the empirical basis underpinning the monetisation of nature effects is very weak. On the one hand, the values expressed in monetary terms have often been taken from other studies that show little or no resemblance to the particular project ("benefit transfers"). On the other hand, it is often unclear which citizens are directly affected by the project. Changing the composition of such an impact population may lead to large fluctuations in the measured costs and benefits. The combination of weakly underpinned benefit transfers multiplied by a difficulty to determine the impacted population provides

an end result that is not very informative.
Furthermore environmental impact assessments often contain detailed data on expected ecological impacts of the proposed project. This information is not usually used in CBAs, as the impacts have not been aggregated and standardised into easy to use units (such as the ton/CO_2 eq produced).

Speaking at the event Jean-Pierre Amigues highlighted a number of other limitations of using economic valuations. For instance, insufficient dialogue between science and policy may result into a misuse (or an insufficient use) of the valuation approach for decision making. The methodological complexity of valuation studies should depend on whether strong local policy implications are expected from the study results. Decision makers often have strong expectations from valuation exercises and the reality of the studies provided does not always match such expectations.

Economic valuation is a complex, spatial and institutional cross-scale problem. Many efforts focusing on particular parts of ecosystems or species, lack the scope to account for the effect of commodity markets for land resources surrounding them. Moreover different types of ecosystem services are valued differently as the spatial scale of the analysis varies (TEEB 2010b). For instance a recreational site may be valued for its direct use at local scale by visitors of the site, whereas high levels of biodiversity may be valued for their existence and altruist benefits at a global scale by the global community.

Non monetary valuation techniques

Example 1: An alternative way of valuing biodiversity with Nature Points

The Netherlands Environmental Assessment Agency has developed a method for the standardised quantification of nature impacts, in the form of a special Nature Value Indicator (NVI). This NVI has been grafted on the internationally often applied criterion Mean Species Abundance (MSA), as an indicator of ecological quality. The Species Weighted Nature Value Indicator (NVISW), or Nature Points, includes a "biodiversity" dimension by weighing ecosystems against each other. The indicator depends on the quality of the ecosystem, the area that the ecosystem covers, and a weighting factor related to rarity of (endangered) species. This process takes into account the degree to which an ecosystem is of benefit to the biodiversity within a region, country or continent. This enables aggregation of the effects caused by changes to nature areas that have various biodiversity qualities, into one concrete nature figure (similar to DALYs – Disability Adjusted Life Years, a measure of overall disease burden, expressed as the number of years lost due to ill-health, disability or early death.). Project effects can thus be expressed in so-called nature points, which subsequently may be included in CBAs (see table 3). Nature Points do not provide insights on the value put by society on nature. It provides insights into the trade-offs between changes the project generates within nature and project effects that can be expressed in euros. This improves the comparison of project

Table 3. Example of cost effectiveness analysis using Nature Points, Frank Dietz, Netherlands Environmental Assessment Agency

	Total Costs (10^6 €)	Nature Value Index (NVI)	Cost effectiveness (NVI / 106 €)
Safety only	1600	0	0
Nature development in IJssel Lake	+790	+3000	3.8
Nature development in Wadden sea	+165	+3300	20
Fish passage only	+10	+1500	150

variants. The weighing up of effects that can be expressed in euros and nature effects that cannot, remains a political consideration.

Example 2: Alternatives to CBA: Measuring trade-offs between hydropower and alpine river ecosystem services (SHARE)

Mountains administrators face an increasing demand of daily water abstraction but lack reliable tools to rigorously evaluate the effects of such abstraction on mountain rivers and the longer term impacts on energy supply and socio-economic benefits. Understanding the relationship between biodiversity and an ecosystem's integrity is essential for the management of natural resources and ecosystem services.

The SHARE project aimed to develop, test and promote a decision support system (DSS) to combine river ecosystems services and hydropower requirements. A Multi-criteria Analysis (MCA) was developed as a "trade-off" tool for evaluating conflicting river management alternatives using quantitative methods instead of monetised values. The project involved public administrators and planners (at the regional level) of mountain areas of 5 countries dealing with rivers hydropower exploitation aspects. For each alternative scenario, a total performance score is calculated using the MCA which takes into account the effects of each management alternative on the specific river system. Decision makers are helped to identify the most sustainable alternative using an interrelated set of weighted indicators tailored towards each specific case requirements. This MCA approach will be tested in 11 pilot case studies.

The methodology was based on a range of ecosystem services quantification methods (Cost-Benefit Analysis; Simple Additive Weighting; Multi-Attribute Utility Theory; Simple Multi-Attribute Rated Technique SMART; Analytic Hierarchy

Process). The project used a range of hydromorphological indicators for integrated river management. The criteria used reflect different stakeholder needs and viewpoints. Weight assignment to the different criteria is a strategic (political) choice. Different weights can be attributed to the same criteria and indicators in different environmental conditions. Indicators are derived from a range of information sources (e.g. law, euro values, expert-based qualitative assessment).

The conclusion of the project is that the SHARE MCA can support both local hydropower assessments and strategic planning for WFD.

Assessing cultural benefits

Ecosystem cultural services are essential to human well-being. The attraction of encountering the natural world is reflected in the large number of civil society organisations embracing landscape and nature interests, people who use green spaces and the growing popularity of gardening. The UK undertook the first comprehensive assessment of national cultural ecosystem services and published its report in 2011. Findings from this study indicate that environmental scenery can contribute to a wide range of health goods often by providing places where people can undertake physical activity and interact with nature. Environmental settings also function as a generator of a vast range of local identities based around a more local and everyday sense of heritage. Environmental settings are valuable surroundings for outdoor learning where engaging with nature can lead to enhanced connectedness to nature and increased ecological knowledge. A well-being survey analysis also reveals that people who visit non-countryside green spaces such as urban parks at least once a month, and those who spend time in their own gardens at least once a week, have higher life satisfaction than those who do not.

Methods to evaluate tangible or "hard” ecosystem services, such as flood control, clean water and air purification, have been well developed in recent decades. However, there is still considerable uncertainty around the services that are of an intangible nature or “soft” services, such as aesthetics, recreational value and cultural heritage for which markets usually do not exist. Cultural services and non-use values in general involve the production of “experiences” that occur in the valuer’s mind. These services are therefore co-produced by ecosystems and people in a deeper sense than other services. Although they may be more difficult to measure, they are essential to sustainable development, which seeks to balance ecological, social and economic values. Ecosystems and their use as cultural landscapes are said to play a crucial role for the identity,

social networks and lifestyles of the local population. Cultural ecosystem services can be strongly correlated with the perceived well-being at least of those people who are directly occupied with land use in a specific region.

In circumstances where the spiritual or cultural values of nature are strong, monetary valuation of biodiversity and ecosystem services may be unnecessary, or even counterproductive if it is seen as contrary to cultural norms or fails to reflect a plurality of values. For example, protected areas such as national parks have historically been established in response to a sense of collective heritage or patrimony, a perception of shared cultural or social value being placed on treasured landscapes, charismatic species or natural wonders. Protective legislation or voluntary agreements can be appropriate responses where biodiversity values are generally recognised and accepted.

Under the TEEB work, the following methodologies are presented for assessing societal and cultural services:

- ➡ travel costs (for recreation, tourism or science related ecosystem services);
- ➡ hedonic pricing methods for assessing the presence of water and aesthetic views based on the price of surrounding real estate or;
- ➡ contingent valuation for spiritual benefits (i.e. existence value).

In the case of wetlands for instance, the TEEB authors (Brander et al., 2010) found that cultural services were mostly based on stated preference methods choice modelling and contingent valuation followed by the travel cost method and benefit transfer methods.

Although the assessment of cultural services is poorly documented a few case studies can be highlighted. Research in Denmark explored methods to evaluate soft ecosystem services in two urban fringe areas in Copenhagen. Three methods were explored for quantifying ecosystem services from the aesthetic and recreational qualities of the areas. The first entailed a research into the historical motivations for developing and choosing to protect these two areas (neither site was chosen in relation to nature conservation but purely on aesthetic reasons and potential recreational use). The second method researched the number of visits received per year in the two areas. The third method looked at the real estate prices (opportunity cost of foregone development land) as a measure of the financial reward that society was willing to sacrifice to maintain the areas for recreation use and aesthetic values.

Further research is required, particularly longitudinal studies, to understand the social and physiological processes involved in people acquiring mental and physical health benefits from engagement with environmental settings and nature so that management of environmental settings for long term behaviour. A project led by the Berlin Brandenburgische Science Academy focuses on analysing the links between cultural ecosystem services and quality of life (see web bibliography).

2.3 – Integrated water resource policy and management applications

Assessing the value of nature and its services provides decision making information for selecting cost-effective local policy measures and also enables to raise awareness of the public on the importance of ecosystems on human well-being. According to EEA calculations, the value of the general services from wetlands at the global value (not just the EU) – such as water purification and carbon absorption – could be around €2.5 billion per year.

The valuation of ecosystem services has potentially strong policy implications for the implementation of the Water Framework Directive

(WFD) in the European Union. It is expected that a sound application of valuation methods, and especially of economic valuation protocols, may improve the current practice of water managers and contribute to a better recognition of the value of protecting aquatic environments in the public debate.

Selection of cost-effective measures

The WFD is based on economic analysis requirements as a decision making tool for optimising the choice of measures according to their cost-effectiveness. ESA reveals the opportunities to work with nature by demonstrating where it offers a cost-effective means of providing valuable benefits (e.g. water supply, carbon storage or reduced flood risk). This provides a useful tool for responding to cost-effective criteria of the WFD.

The cost benefit analysis of the dike relocation of the river Elbe presented earlier provides a clear cut decision making tool for selecting the most cost-effective solution based on a number of cost criteria (project costs) and benefits (saved maintenance costs, avoided flood damage, biodiversity improvements and nutrient retention). It is important to note that the analysis is based on a selection of costs and benefits as it is not possible to assess and quantify all of these.

Beyond the numerical aspect of the cost-benefit analysis, the study also looked at distributional effects of benefits and costs along the river Elbe. Results were disaggregated per 50 km river stretches in order to visualize benefits on a map. This provided information to the governance structure (Bundesländer) on which groups of stakeholders bear the costs and which ones reap benefits from different options. The results helped discussions between environmental protection organizations and other stakeholders.

Cost recovery methodologies for water resources management

As part of the first Romanian River Basin Management Plan, the National Administration for Romanian Waters sought to analyse environmental costs under the cost recovery article requirement of the WFD.

A cost recovery analysis was undertaken for wastewater collection and water treatment services using a substitute cost method. Fisheries and biomass production were evaluated using a cost based method. As regards valuating the supporting services provided by wetlands, the team compared it with an alternative land use (converting the wetland into cropped land).

When natural resources or other kinds of public goods are at stake, their costs should include not only the financial aspects, but also scarcity costs and externality costs; while the presence of positive externalities and public good dimensions should also be accounted for on the benefits side.

This rule can also be applied to water. What makes this issue problematic in the water sector, however, is the fact that in most of the cases, water services are based on bulky infrastructure which is characterized by a high one-off fixed cost with very low marginal costs. In the case of water, most ecosystem services cannot be separated from the services supplied by artificial capital and man-made water management systems (infrastructure).

The appropriate incentive structure should ensure that an adequate effort is put in place in order to develop and maintain the man-made water management system. But how do we share the costs of the water system? This generates sustainability issues: water services should be affordable, but also financially sustainable in the long run bearing in mind that the economic life of infrastructure spans usually several decades (issue of intergenerational equity). Therefore, we need to be more creative and find ways to develop appropriate management and cost sharing solutions.

There are alternative ways of recovering infrastructure costs than charging a volume charge to users. Indeed cost recovery and financial sustainability can be achieved in principle through any kind of economic instrument, including flat charges, ear-marked taxation or criteria based on social equity.

The economic incentive should be targeted at the effectiveness in promoting the desired behaviour by water users and suppliers of water services, regardless its actual relation with the costs. Furthermore, a number of ecosystem services can potentially generate economic rents over and above normal profits. A portion of the rent should be reinvested into the service protection (e.g. in some countries, licenses for the extraction of gravel are provided on the basis that the industry returns and invests into gravel sand pit restoration).

In this context payment for Ecosystem Services (PES) is a sub-optimal solution to cost-recovery (as it equates to being a subsidy) which denies the polluter pay principles and has the potential harmful effects of subsidies. The advantage of PES is that it is seen as way to reconcile conflicting water uses ('new urban rural compact') which is a practical tool for by bypassing transaction costs and achieve consensus over a cost-effective solution.

Designing policy incentives for conservation

An ecosystem services approach can enhance conservation strategies by providing access to new sources of long-term financing, supporting greater impact at a wider scale, and opening new avenues for advancing conservation with institutions that do not traditionally consider the environment in their decision-making. However, an ecosystem services approach may not always be the best way to achieve conservation. Success depends on an enabling context and effective project design. It is therefore critical to screen an ecosystem services approach early on.

Strategic Environmental Assessments (SEAs) are increasingly institutionalized within government decision-making, particularly in developed countries[18]. SEAs are broader in scope than Environmental Impact Assessments (EIA), and typically involve sectors such as spatial and land-use planning, water, waste, transport, and energy (Sadler, 2000). Considering a broad range of ecosystem services helps ensure an SEA includes a comprehensive and balanced assessment of environmental impacts and considers the trade-offs of alternative options. The InVEST project[19] is developing tools which can help support an SEA by identifying how policies, plans and programs can meet multiple goals and guiding selection of the best alternatives. Scenario planning can increase the impact of ecosystem services assessments on decisions. They enable proactive, forward-looking, comparative assessments. Scenarios can frame studies to explore the potential impacts of uncertain changes that may occur in the future. Scenarios can also frame studies to understand the likely consequences of alternative decisions, policies and plans. Through scenarios, one can elucidate how the many drivers of environmental change interact. More tools are required to develop guidelines on how scenarios for ecosystem services analyses can support decision making.

Biodiversity offsets are conservation actions intended to compensate for the residual, unavoidable harm to biodiversity caused by development projects, so as to ensure no net loss of biodiversity. Offset programs can be expanded to include actions that compensate for loss of ecosystem services, such as erosion control and water purification. Offsets follow a mitigation hierarchy,

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[18] See the EU SEA Directive 2001/42/EC.
[19] InVEST (Integrated Valuation of Ecosystem Services and Tradeoffs) is a freely-available software tool developed by the Natural Capital Project – a partnership of Stanford University, The Nature Conservancy and World Wildlife Fund. See websites.

where harmful impacts are preferably avoided, then mitigated, and finally offset.

Payment for Ecosystem Services (PES) are contractual and voluntary transactions where a "buyer" agrees to provide "payment" to a "seller" conditional on delivery of an environmental service, or implementation of a land use or management practice likely to secure that service. PES create financial incentives to protect, restore, or sustain environmental services provided by watersheds.

Establishing PES often takes years, requiring extensive stakeholder engagement to build trust and commitment. Classic cases of PES include the system established by New York City (detailed below) in the Catskills. Activities subsidised by PES can include restoring wetlands and maintaining native vegetation. While there is still debate on whether PES are an efficient way to improve or maintain environmental services and biodiversity, interest in establishing PES is growing rapidly.

A number of PES case studies were presented at the 2011 SPI event. Payment programmes for ecosystem services are being developed in many countries around the world. They are essential in providing adequate rewards to landowners who protect ecosystem services that are valuable to society.

Example 1: The Catskills Delaware watershed restoration

Figure13. The Catskills Delaware watershed restoration - New York City, Department of Environmental Protection

New York City's 9 million inhabitants obtain 90% of their drinking water supplies from the Catskill and Delaware watersheds, situated 130 miles outside the city, which filter water through the ecosystem's waterways and wetlands. Altogether, these regions cover an area of around 1500 square miles and support over 75 000 residents. Historically these watersheds provided very high quality drinking water, but by the late 1980s they became degraded through a combination of land conversion, development and negligence that resulted in sewage and agricultural runoff polluting the waterways.

However, instead of building a water filtration plant with estimated construction costs of \$6–8 billion (US) and a further \$300 million (US) in annual operating costs, the municipal

government opted to invest in restoring the Catskill and Delaware watersheds. The cost of restoring the health of these watersheds, and therefore their water filtration services, was only $1– 1.5 billion (US). This decision amounted to investing in natural capital in place of physical capital, with the understanding that if correctly managed the watersheds could provide the same filtration services as the proposed water filtration plant, but for a fraction of the cost.

The restoration efforts included rewarding farmers who adopted best management practices, compensating landowners for restrictions on private development and subsidizing improvements to septic treatment systems (Hancock, 2010). In the end, the ecosystem services option came to a 1/8th of the cost of the filtration plant.

Example 2: Payment for Ecosystem Services in south west England

South West Water have recognized that it is cheaper to help farmers deliver cleaner raw water (water in rivers and streams) than it is to pay for the expensive filtration equipment that is required for them to treat polluted water after it is abstracted from the river for drinking. The water purification service provided by rivers was monetised and used to develop a market to compensate farmers for undergoing alternative practices. Measures included riverbank fencing, prevention of cattle lameness, straying and infection and rainwater harvesting for use in slurry pits.

The benefits reaped through the measures resulted in cost savings for farmers. What makes the project even more beneficial is that, in addition to improving raw water quality, there are likely to be a wide array of additional benefits (restored biodiversity and landscapes). In this project it was not seen helpful to provide many quantification details on ecosystem services, and information was kept at a strategic/global level.

Communication and participatory value of the ESA

ESA creates a common language for policymakers, business and society that enable the real value of natural capital, and the flows of services it provides, to become visible and be mainstreamed in decision making (TEEB 2010a).

A range of case studies from the UK[20] have indicated a number of lessons in terms of the contribution of the ESA towards greater and more effective communication and stakeholder participation (see figure 14).
Firstly, ecosystem services are an intuitive way with which people relate to ecosystems. It puts “ecosystems” in terms which people from all types of backgrounds (ecological, social…) can relate to. It helps understand and assess un-intended consequences, a well-understood example being the industrialisation of agriculture to maximise the provisioning service of “food” and “fibre” production that has frequently resulted in net cost to other

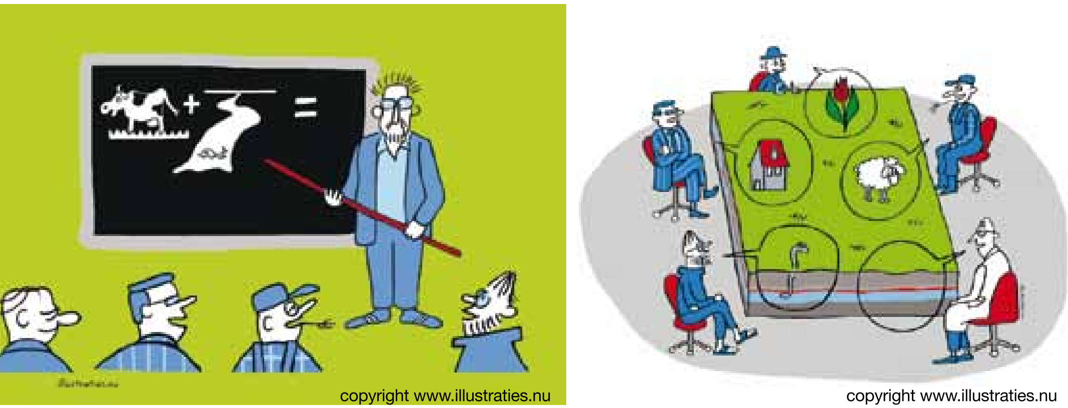

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Figure 14. The ESA role for improving communication and participation among stakeholders (source : Brils J. Harris B. (Eds.), 2009 ; Brils J. Moolenaar S., 2011)

[20] See presentation of Mark EVERARD, EAEW, UK, in Chapter 4.


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provisioning service such as genetic stock, as well as regulatory, cultural and supporting services. In the Dutch case study for example, the farmers that took part in the Payment for Ecosystem Services scheme became so convinced of the utility of their ecologically friendly practices introduced as part of the scheme that some even opted to create additional habitats for species, over and beyond that defined in the PES agreement.

Secondly, ecosystem services also help us to recognise all stakeholders likely to be affected by decisions, and therefore those who should be included in the deliberative process. This in turn can facilitate more effective communication and engagement with people in socially meaningful terms.

The PSI-Connect team led a role playing game as one of the event round tables[21] . The objective of the Role Playing Game was for participants to develop an understanding of how the concept of ecosystem services can be applied within water policy and how to evaluate trade-offs in river catchment management. In the game participants were engaged in identifying and "trading" ecosystem services within the context of river restoration. Overall, the participants agreed that they learned something about ecosystem services. Those with no or little previous knowledge about ecosystem services had

[21] See Chapter 6 for a full description of the role playing game.

gained an understanding of the wide range of ecosystem services that exist and an insight into the complex interrelations and trade-offs. This also sparked interest in wanting to learn more about ecosystem services. Those with previous knowledge emphasised the new way of understanding the various perspectives on ecosystem services through experiencing these in the game. Using the concept of ecosystem services was deemed to be a strong tool for stakeholders in river catchment management leading to a new approach of communicating with each other. However, challenges are seen in the next step of how to implement ecosystem services and tackle the issue of payments.

ESA: a shift from narrow WFD compliance to systemic approach to water management

Speaking at the conference, Mark Everard provided an overview of the paradigm shift provided through ecosystem services. Historic approaches to water management, as indeed many facets of the environment, have largely relied upon a discipline-specific basis. The relatively recent emergence of ecosystem services into mainstream European environmental thinking presents an opportunity to deliberate more systemically about the range of public benefits provided by catchments and other ecosystems.

An ecosystem services perspective helps overcome the unintended consequences that have often stemmed from a narrow disciplinary focus, including for example wider biodiversity, water quality and landscape degradation stemming from a narrow focus on food production in land use policy, or the large increases in greenhouse gas generation associated with intensification of wastewater treatment.

The ESA thereby helps maximise the range of public benefits potentially stemming from the ways in which we use land, apply technological solutions, direct subsidies and undertake other management interventions. The Mayes Brook restoration and associated Mayesbrook Park regeneration project in urban east London used the ES approach to deliver additional intended benefits such as air quality from tree growth, access, recreation and amenity for people who often lacked gardens, nutrient cycling, habitat for wildlife, flood risk management, carbon sequestration and a range of other benefits.

Reconceptualising how the WFD could be more effectively implemented by applying ecosystem services is also informed by two pilot WFD studies undertaken in England. The shift in focus is from narrow compliance with quality standards towards consideration of the many societal benefits for which these metrics are indicators.

The lessons emerging from these studies suggest that planning needs to expand from individual water body and pressure-by-pressure scales to thinking about strategic interventions at the whole-catchment scale, including measures most likely to deliver a wider range of benefits both geographically and temporally, and to multiple stakeholder groups.


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3 Policy recommendations

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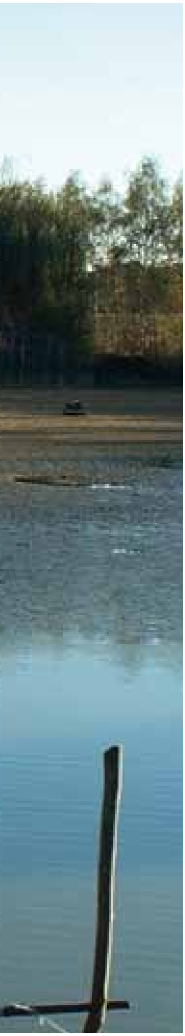
and research gaps



3.1 – Ecosystem services and water management: where do we stand?

An approach enticing growing interest and application: appropriation and normalisation still needed

The concept of ecosystem services, although developed a few decades ago, is still a relatively new concept especially amongst water policy makers and managers. A number of subtle differences in terminology (e.g. environmental services and ecological services) can be noted between scientists which suggests that the concept is not yet normalised.

Ecosystem services approaches have a number of objectives which include:

➡ raising awareness on the importance of conserving ecosystems and their biodiversity;

➡ understanding in economic, socio-economic and ecological terms their significance in relation to human activities and well-being;

➡ providing a new communication and systemic framework between policy-makers, scientists and the public on nature and society inter-linkages;

➡ promoting the idea that maintaining natural capital through conservation and restoration programmes will help sustain the provision of ecosystem services which we depend on.

Links between ecosystem services and ecological status: an intuitive approach that would benefit from more formalised and standardised tools

Although further research is still needed, such as on the links between biodiversity and ecosystem services, we are gradually gaining a better understanding of ecological processes and functions and links between these and the supply of ecosystem services. Sustaining ecosystem services flows requires a good understanding of how ecosystems function and provide services, and how they are likely to be affected by various pressures. Insights from the natural sciences are essential to understanding the links between biodiversity and the supply of ecosystem services, including ecosystem resilience. Most services provided by ecosystems depend on the conservation status of ecosystems (some authors refer in this case to "ecological services").

Aquatic ecosystems sustain a number of key regulatory functions. Flood plains regulate the water regime (storage during floods and release during low water levels). They regulate the distribution of water in time (flood risk prevention), the scale of runoff and aquifer and water body recharge. The preservation and restoration of river dynamics which promotes (amongst others) the maintenance of aquatic corridors and biodiversity, help reduce risks of flood damage in vulnerable zones.

Aquatic systems absorb and detoxify heavy metals, excess nutrients or pesticides thanks to biological and physical processes in the soil or sub-soil. Nitrogen loading in the environment has multiple effects: on the one hand it enhances crop production, coastal fish production and water purification, on the other it can also affect drinking water quality, reduce recreation opportunities and alter ecological status. This illustrates the complex synergies and trade-offs between ecosystem services and ecological status.

The capacity of aquatic systems and wetlands to provide supporting services (such as soil formation, nutrient cycles, photosynthesis, water cycle) is often degraded due to hydromorphological alterations which alter river dynamics and the correct functioning of the aquatic ecosystem. Studies have shown that a river with diverse morphological characteristics has increased water purification potential.

A number of projects presented at the 2nd SPI event have sought to model the links between ecological processes, good ecological status and the provision of ecosystem services. In particular, the following initiatives were presented:

- a study implemented by TU Berlin and financed by the German Federal Agency for Nature Protection[22] (BfN) compared the cost and benefits of relocating dikes (to enlarge the river bed) compared with establishing flood polders (specifically designated flood retention areas which can be opened for flooding upon demand). It showed that flood protection was greater with the dike relocation option (reduced maximum flow and water height);
- the JRC undertook an assessment[23] of the contribution of river networks to purifying water through the removal of excess nitrogen from runoff water in Europe. The results of the study show that about 1.5 million tons of nitrogen are removed by rivers per year, which equates to the amount of nitrogen produced through point sources. Rivers and lakes provide at no cost the denitrification service which increases the quality of surface waters. Furthermore, the development of ecosystem services maps and models help estimate where ecosystem services are produced, quantify the changes in service provision over time, and describe the

[22] See Chapter 5 Roundtable 1 for a description of the case study.
[23] See Chapter 4 paragraph 4 and the report from JRC (2011), European assessment of the provision of Ecosystem.

production of ecosystem services as a function of patterns of land use, climate and environmental variation. Using a principal component analysis (PCA), the JRC was also able to assess trade-offs between the mapped ecosystem services (in terms of whether two or several ecosystems services were correlated – positively or negatively – or uncorrelated).

The denitrification function of ecosystems was particularly investigated with the following results:

- ➡ the rate of nitrogen removal is higher in water bodies with a poor to moderate ecological status;
- ➡ the biological processes which increase the capacity of river basins to retain nitrogen seem to include: primary production of nitrogen (uptake of nitrogen by macrophytes and algae in riparian wetlands and floodplains) and sedimentation and denitrification;
- ➡ denitrification benefits tend to be received in downstream areas whereas economic values are generated in upstream areas.

More generally, understanding the drivers of water quality is important for addressing WFD requirements, better management of treatment costs and forecasting impacts on water recreation. Under the UK National Ecosystem Assessment research, drivers of river water quality improvement in UK catchments were found to include: less root crops (potatoes, sugar beets), less dairy cows, less temporary grasslands, less suspended sediment, lower water temperature, higher rainfall and higher river flows.

Links between hydro-morphological status and ecosystem services were also highlighted:

- ➡ channel and floodplain morphology (including lateral and longitudinal connectivity) and sediment transport regime (including amount, timing and size) are important geomorphological characteristics which support many ecosystem services;
- ➡ although sometimes considered itself as an environmental service,

hydropower has a number of direct impacts on mountain hydrosystems including abiotic alteration (temperature regime, oxygen regime, trophic state), physical alteration (hydrology, morphology, sediment balance), and changes in aquatic species composition. Ecosystem services (freshwater provisioning, loss of habitat, extreme hydrological events regulation, sediment balance, water purification, recreation, local climate regulation) are thus often compromised and may conflict with hydropower production. The current WFD ecological quality indicators do not seem to be relevant for measuring hydropower pressures. Hydromorphological indicators – such as those developed by the SHARE project - are particularly fitted to represent ecosystem services exposed to hydropower exploitation pressures.

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Finally, thinking the restoration of good ecological status to optimise ecosystem services has also been addressed by several concrete examples of ecological engineering presented during the event. These included:

- ➡ tree planting to influence water infiltration (TRUST project in Veneto-Friuli basin, Italy);
- ➡ dike relocation in Germany for more cost-effective flood protection measures;
- ➡ hydraulic regulation in Alpine rivers for optimising the trade-offs between ecosystem services and hydroelectricity provision (SHARE project).

Valuation and economic assessment: a short state of the art of existing methods

The European Environment Agency (EEA) has highlighted the need for ecosystem accounting techniques to analyse the relationship between economic sectors and their reliance and impacts on ecosystem goods and services[24]. Ultimately, this data should feed into policy-making and local management of natural resources. A number of economic valuation case studies were presented at the 2nd SPI event. Below is a summary of some of the methods used for assessing costs and benefits of changes in ecosystem services (in particular see presentation on the Elbe river restoration Cost Benefit Analysis case study[25]).

- ➡ changes in flood protection: benefits can be measured through avoided property damages whereas costs include: investment costs, rehabilitation costs, maintenance costs, and opportunity costs of agricultural and forestry land;
- ➡ changes in wetlands biodiversity: methods include "benefit transfers[26]" from other studies based on willingness to pay studies near riverine wetlands;

[24] For further information see : An experimental framework for ecosystem capital accounting in Europe, EEA Technical report, N° 13/2011.
[25] Refer to Chapter 2.1 and 5.1.
[26] A practice used to estimate economic values for ecosystem services by transferring information available from studies already completed in one location or context to another. This can be done as a unit value transfer or a function transfer.

- ➡ changes in nutrient retention of wetlands: calculations are based on replacement costs, using the MONERIS model on nutrient discharge and retention[27];
- ➡ changes in river water quality: methods include undertaking "willingness to pay" surveys in order to obtain values for an increase in quality, or using records of visit frequency and visit costs.

Numerous methodological issues exist when it comes to economic valuation. A major challenge is how to account for future generations as well as non-use values, which are difficult to estimate in monetary terms. Alternatives to cost benefits assessments were presented at the event and include: the Nature Value indicator developed by ecologists of the PBL Netherlands Environmental Assessment Agency as a standardised quantification of nature impacts. This NVI has been grafted on the internationally often applied criterion Mean Species Abundance (MSA), as an indicator of ecological quality. Other methods include the Multiple Criteria Analysis. The SHARE project developed a MCA for evaluating conflicting river management alternatives using quantitative methods instead of monetised values. The methodology was based on a range of ecosystem services quantification methods (Cost-Benefit Analysis; Simple Additive Weighting; Multi-Attribute Utility Theory; Simple Multi-Attribute Rated Technique SMART; Analytic Hierarchy Process).

Assessing cultural and societal benefits is perhaps one of the lesser developed fields in valuation. Methods to evaluate tangible ecosystem services, such as flood control, clean water and air purification, have been well developed in recent decades. However, there is still considerable uncertainty around the services that are of an intangible nature such as aesthetics, recreational

[27] For more information on the model see website.

value and cultural heritage for which markets usually do not exist. In circumstances where the spiritual or cultural values of nature are strong, monetary valuation of biodiversity and ecosystem services may be unnecessary, or even counterproductive. A number of methodologies however exist to assess cultural ecosystem services (travel costs, hedonic pricing and contingent valuation methods) and have been tested by the TEEB.

An educational and pedagogic tool to highlight the interdependence of human societies and ecosystems

A range of case studies from the UK[28] have indicated a number of lessons in terms of the contribution of the ESA towards greater and more effective communication and stakeholder participation. Ecosystem services are an intuitive way to help people relate to ecosystems. Ecosystem services also help us recognise all stakeholders likely to be affected by decisions, and therefore those who should be included in the deliberative process. This in turn can facilitate more effective communication and engagement with people in socially meaningful terms.

ESA: a useful tool for water and natural resources management

A linking concept between environmental policies and with other sectoral policies

The strong criticism of the traditional "silo approach" observed in natural resource sector strategies is gradually providing more legitimacy for adopting a more systemic approach – such as ecosystem services approach - to environmental management. The ESA thereby helps maximise the range of public benefits potentially stemming from the ways in which we use land, apply technological solutions, direct subsidies and undertake other management interventions. Water managers

[28] See presentation of Mark EVERARD, EAEW, UK, in Chapter 4.

may in the future be tasked with reporting on the identification, characterisation and evaluation of ecosystem services. This will require them to mobilise a range of tools from disciplines such as ecology, economics, legislation, sociology and politics.

However, even though the ES approach is being applied in many countries at the local scale, the lack of systemic policy planning between local and national levels can generate conflicting messages between different land use purposes, each sectoral policy favouring a particular ecosystem service over another. However a narrow interpretation of the ESA approach i.e. the focus on only a selection of ecosystem services can be counterproductive if ES are promoted independently of the whole ecosystem for the purposes of justifying selective policies and land use choices.


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The lessons emerging from studies suggest that planning needs to expand from individual water body and pressure-by-pressure scales to thinking about strategic interventions at the whole-catchment scale, including measures most likely to deliver a wider range of benefits both geographically and temporally, and to multiple stakeholder groups.

ESA is perceived as a "linking concept" between nature protection, water management, energy and other environmental sectors. It can also act as a focal point for linking different policies such as the Marine Strategy Framework Directive, the Floods Directive, the Nitrates Directive and the Water Framework Directive.

Gradually, European and international strategies are embracing the concept of ecosystem services and setting targets to halt the degradation of ecosystem services (EU Biodiversity Strategy and global Strategic Plan for Biodiversity 2011-2020). The 2012 Blueprint to Safeguard Europe's Waters will provide an overview of the state of aquatic ecosystems. Measures being looked at include indicative targets based on the maximisation of net social benefits from water use.

Ecosystem services are becoming a core of policy making tools such as Strategic Environmental Assessments, scenario planning, biodiversity offsets and Payments for Ecosystem Services. The latter can help promote changes in landowner practices by rewarding to landowners who protect ecosystem services that are valuable to society; however PES is still controversial in some cases as it goes against the polluter pays principle , a fundamental principle of EU environmental policy.

A concept to support various steps of WFD implementation

The ESA brings a number of opportunities for WFD implementation. Firstly, it is expected to provide responses on the WFD-economics requirements, the issue of exemptions justification and support the evaluation of the 1st RBMP round. In order to assess whether costs to achieve Good Ecological Status are disproportionate or not, one needs to compare the costs of the Programme of Measures with the benefits of achieving good ecological status. Traditionally this is done through a cost benefit analysis and thus requires valuing environmental benefits which ecosystem services are part of. At the strategic level (river basin scale) it could be used for balancing policies and selecting between policy options; at the local level (water body) it can help unravel specific situations in "hot spots" with societal conflicts or high ecological threats. This can also be useful for designing and enforcing both RBMPs and programmes of measures.

It is expected that a sound application of valuation methods, and especially of economic valuation protocols, may improve the current practices of water managers and contribute to a better recognition of the value of protecting aquatic environments in the public debate. The WFD is based on economic analysis requirements as a decision making tool for optimising the choice of measures according to their cost-effectiveness. The cost benefit analysis of the dike relocation of the river Elbe for instance provides a clear cut decision making tool for selecting the most cost-effective solution based on a number of cost criteria (project costs) and benefits (saved maintenance costs, avoided flood damage, biodiversity improvements and nutrient retention).

Scale issues: to be carefully considered at every step of assessment and decision support

Several challenges have already been identified regarding the cross-cutting issue of scale, such as:

➡ setting the right scale for ESA. The scale at which ES assessments are carried out is important. Any ecosystem assessment should be bounded by spatial and temporal scales that are appropriate to the objectives of local policy makers and natural ressources managers. Boundaries for management will be defined operationally by users, managers, scientists and local people. It may therefore be helpful to widen the usual geographic scope of aquatic ecosystem to encompass physical, biological and socio-economic components of the aquatic environment;

➡ accounting for larger scale effects - Global pressures at large spatial scales such as climate change, source populations and the effect of discharge changes on sediments and channel dynamics affect the local ecological status and may even constrain the effect of local restoration measures. These wider scale issues (linked to the river continuum and upstream/downstream interdependencies) are rarely considered in RBMPs;

➡ dealing with data at different scales - The spatial scale at which pan-European ES indicators can be mapped depends essentially on the mapping resolution of the biophysical models that have been used to derive the indicators. The spatial unit of a trade-off assessment will be a compromise between the different spatial units in which the indicators can be computed and more importantly, the spatial resolution at which an economic valuation is still meaningful;

➡ economic valuation and scale effects - Different types of ecosystem services are valued differently as the spatial scale of the analysis varies. Research is still needed to develop valuation tools which integrate values at different scales.

3.2 – Research gaps and knowledge management

Gather and analyse on-going research projects and experimentations

Many initiatives have been undertaken, both within research projects and with operational goals. Making these results readily accessible and stimulating their analysis should be made a priority.

Some on-going research initiatives to be followed are:

➡ EEA European Ecosystem Assessment (EURECA) as a follow-up to the Millennium Assessment by 2015;

➡ DIVERSITAS, the Group on Earth Observations - Biodiversity Observation Network (GEO BON) working group 6 on ecosystem services focuses on the (under-researched) linkages between ecosystem functioning and ecosystem services, as well as some relationships between ecosystem services and human well being;

➡ the RUBICODE project which focuses on assessing the ecological resilience of those components of biological diversity essential for maintaining ecosystem services;

➡ the Ecosystem Services Partnership which focuses on researching on the dynamics and Valuation of Ecosystem Services and Natural Capital (develop quantification methods, models and data bases);

➡ the USA Quadrennial Ecosystems Services Trends (QuEST) Assessment which

© Sylvie Vieillard - Asconit Communication would draw upon ongoing monitoring programs as well as newly recommended activities to identify trends related to ecosystem sustainability and possible policy response;

➡ manual and web-based tool to support the valuation of ecosystem services in Flanders, Belgium (Natuurwaardeverkenner);

➡ valuing the impacts of ecosystem service interactions for policy effectiveness, UK funded by NERC Valuing Nature Network;

➡ interdisciplinary quantitative ecosystem services team (INQUEST), UK funded by NERC Valuing Nature Network.

See Nature Valuation and Financing Network website for a comprehensive review of ongoing initiatives and knowledge management on ecosystem services valuation.

Learning from more a diverse set of case studies

Additional and more diverse ecosystem services assessment case studies are needed in order to develop operational tools for better planning and assessment frameworks which break out from silos, provide practical methods for valuation, creating conditions for public awareness, better participation and decision-making. An information platform has been set up as part of the Biodiversity Information System for Europe (BISE). information System for Europe (BISE) to facilitate the planning and development of ecosystem assessments in Europe and includes a repository of ESA case studies.

There are a number of projects working on this theme (IWRM-net FORECASTER looking at the ecological effects of hydromorphology degradation and positioning hydromorphology in river rehabilitation strategies). In total there are 81 INTERREG projects and 172 LIFE projects dealing with flood management, integrated river basin management, river floodplain restoration, water quality improvement projects but there is no synthesis of these experiences.

Develop more accurate methods of identification and assessment of ecosystem services

There are scientific issues regarding a rigorous identification and definition of these services and the type of spatial entities to be considered in a valuation exercise. The strong ecological interactions between aquatic and terrestrial environments complicate the definition of the right spatial entity and transition zones (e.g. buffer zones which are often the source of many ES) from one habitat to the next. Many aquatic ecosystems are highly artificialised or already submitted to intense anthropogenic pressure, so that "pristine" or "natural" status is difficult to assess. Aquatic environments are also very dynamic and changing (through both natural dynamics and anthropic disturbance). It is not clear how this is taken into consideration. Further research is needed on developing methods to encompass the dynamic nature of ecosystems and in choosing the correct boundaries for the purpose of an ecosystem services assessment.

Furthering our understanding of ecosystems and links with ecosystems services

A great deal of uncertainty and knowledge gaps remains in terms of deciphering linkages between ecosystem structures, processes and functions.

There is a need to develop appropriate tools for river condition assessment which are based on a sound geomorphological approach and on understanding river processes. The lack of specific consideration of channel processes and trends of channel changes is probably the main limitation of existing methods, which are therefore poorly suited to an understanding of the pressure-response chain in the context of rehabilitation actions. A sounder knowledge and consideration of river physics might help us overcome the discrepancy between biological and hydromorphological indicators. For instance:


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under the WFD criteria ecosystems may have been assessed to be in a good ecological status, although their hydromorphological conditions may not be. Hydromorphological indicators are only taken into consideration for distinguishing between "good" and "very good" water body quality.

Research is also needed to provide knowledge on the impact of multiple drivers including land use change on structural and functional capacity of aquatic ecosystems (such as biodiversity and tipping points) and on the impacts on quality and provision of different ecosystem services. Research is needed to provide a better understanding of how policy (Water Framework Directive, green infrastructure) and management choices (ecological restoration) can change the provision and quality of ecosystem services.

In addition to focusing on additional research on the bio-physical aspects of ecosystems (processes and functions), further research is required on qualifying the linkages between ecosystem functions and services. Lastly, we also need to gain a better understanding of the linkages between different aquatic ecosystem services (trade-offs, synergies and antagonisms between ES). The JRC report and the UK NEA both analyse relations between ecosystem services (positive and negative correlations).

The call for research proposals[29] launched by the EC FP7 programme in summer 2011 should provide interesting responses on this matter. This research is aimed at exploring, demonstrating and validating mechanisms, instruments and best practices that will serve to maintain and enhance a sustainable flow of a broad range of services from ecosystems while preserving their ecological value and biological diversity. Amongst the tools needed, policy makers lack integrated modeling tools which integrate natural and social sciences (e.g. impact of food policies on carbon sequestration, recreation…etc).

Developing indicators of ecosystem services

It would help to have indicators on water quantity and quality similar to the carbon taxation system (CO_2 teq) or the water footprint[30].These indicators could include state indicators (describing what ecosystem process or component is providing the service and how much) and performance indicators (describing how much of the service can be potentially used in a sustainable way). Research on nutrient economic markets and scientific literature exists. It will be important to translate this into water policy.

Optimize and develop valuation methods

Addressing environmental valuation knowledge gaps

There is a limited number of empirical studies related to economic evaluation of costs/associated benefits of changes in quantity and quality of the water resources and of the key services provided

[29] ENV.2012.6.2-1 Exploration of the operational potential of the concepts of ecosystem services and natural capital to systematically inform sustainable land, water and urban management -FP7-ENV-2012-two-stage.
[30] The water footprint is an indicator of water use that looks at both direct and indirect water use of a consumer or producer. The water footprint of an individual, community or business is defined as the total volume of freshwater that is used to produce the goods and services consumed by the individual or community or produced by the business (see website).

by aquatic ecosystems based on conceptual and analytical models. More robust economic case studies should be produced and methods disseminated. Databases which document valuation case studies exist (e.g. Nature Valuation and Financing Network) however without sustained funding they are not maintained.

Research gaps regarding valuation methods include: dealing with the "long" water cycle challenge, defining the right "ecological entity", the supply and demand of ecological services, primary versus secondary ecosystem services, accounting for future generations and the inclusion of ecosystem services valuation into environmental project management.

Experiment the creation of markets through greater private sector involvement

Markets should eventually be created to promote the provision of a range of ecosystem services if we can show that these will have a positive effect on ecological status. Research programmes which encourage the participation of the private sector should be encouraged.

Work on public awareness tools and programs

There is currently an extremely high gap in what the general public and water managers understand of ecosystem goods and services. The concepts around ecosystem services are still in their development stage amongst researchers and it will be some time until these concepts "norm" into internationally accepted definition and ideas. However, similarly to climate change adaptation and biodiversity which have raised a great deal of awareness raising in the past years (e.g. 2010 was the year of Biodiversity), it may be useful to plan environmental education programmes and awareness raising tools on aquatic ecosystem services and their importance for human well-being.

Translate research results into policy relevant tools

Another research gap is how to transfer knowledge to policy makers in the most effective way as economic results can sometimes clash with political expectations. More socio-political research is required to translate knowledge into evidence and operational tools for policy-makers. This includes "retrofitting" existing tools such as cost benefit analysis; and environmental impact assessments. Partnerships will have a great role to play, especially innovative partnerships with industry. We need to create better interfaces between science and policy, between science and markets and between science and citizens.

3.3 – Policy perspectives and recommendations

EU policy context

Already a number of European policies have integrated the concept of ecosystem services and provide perspectives for their promotion and application of related approaches.

The EC adopted the Roadmap for Resources Efficiency in September 2011 which presents milestones and commitments to horizon 2050. The document presents the necessary transition towards sustainable economies, which starts by identifying economic sectors that consume the most resources. Natural resources management is also looked at. The report includes recommendations on integrated actions across barriers and sectors at Member States and EU levels. The document presents mechanisms and participatory processes to reach the targets. Ecosystem Services feature in the roadmap and the EU Biodiversity Strategy where by 2014 ecosystem services will be measured by each Member State and valued by 2020. A biodiversity financing facility is also being set up with the European Investment Bank, public and private partners.

The preparation for the 2012 Blueprint Safeguard Europe's Waters has shown that the ecosystem services approach can be useful at different stages of the WFD implementation: firstly for the analysis of water bodies ecological status and main pressures; secondly for the definition of Programmes of Measures; thirdly during the implementation stage where ecosystem services can provide insights for ecological engineering, decision-making and participation. However, one of the key requirements for successful utilisation of the ecosystem services concept is to harmonise regulations across different European Directives and to reverse perverse incentives.

A concept useful to support decision making

Policy makers need to embrace a systemic view of ecosystem services and in this regard need to rely on mapping tools. Ecosystem services approach allows a systemic and global assessment of different management options (especially regarding land use). It helps the prioritisation of financial resources for integrated water management programmes and improves the efficiency of resource use.

Ecosystem services are a convincing and practical concept to structure multifunctional aspects in economic appraisals. For instance, dike relocation is an economically worthwhile option to improve the morphological quality of lowland water bodies. The spatially explicit identification of changes within the biophysical realm and land-use changes are important for policy makers. Including uncertainties is critical for the estimates of quantities and values.

Support WFD implementation along the whole process

An ecosystem services approach could come into play at various steps of WFD implementation:

- at the stage of Assessment, WFD implementation will benefit from a fine scale (water body) appraisal of both ecological functions and services, as well as coarser assessments (river basin to national) relying on mapping tools to integrate land use information. This could also help the definition of good ecological potential of highly modified and artificial water bodies;
- in view to design the Programme of Measures, ecosystem service approach will allow to build a more integrated approach, through measures that address different degradation factors as well as through a more systemic approach for highly degraded water bodies. This would also have implications to address both restoration and preservation issues.

Such a methodology could be applied to other environmental regulations, whether specific to water management issues (eg Floods Directive, Nitrates Directive) or not (eg Natura 2000).

3.4 – Follow-up recommendations

The event's topic generated much interest from the participants, regardless of their previous level of knowledge on ecosystems services. From the feedback provided by the participants of the workshop, there is a need for developing guidelines on ecosystem services application to WFD implementation aimed at strengthening knowledge and understanding of ecosystem services and their valuation.

One of the possibilities would be to set-up a temporary activity within the Common Implementation Strategy (CIS) to develop operational guidelines for ESA and to promote their implementation in the second river basin management plans (RBMPs).

Linked to the WFD implementation challenges, including economical expertise and environmental costs issues, this activity would gather experts both from science and policy backgrounds in order to elaborate some general guidelines and examples of good practices of ESA, and an assessment of information gaps and identification of future tasks for development of more detailed technical recommendations. This work could be timely linked to the Blueprint to Safeguard Europe's Waters a view to delivering inputs to it and its follow-up.

This work would consist of:

- ➡ undertaking a review of existing knowledge and state of the art for ESA implementation;
- ➡ evaluating the applicability of the concept for WFD implementation;
- ➡ recommending some good practices for ESA implementation;
- ➡ supporting implementation of these guidelines in the second river basin management plans (RBMPs).

Any follow-up activity should also link up with the work of the EU Biodiversity Strategy Common Implementation Framework (CIF) which is tasked with developing tools for ecosystem services mapping and assessment.


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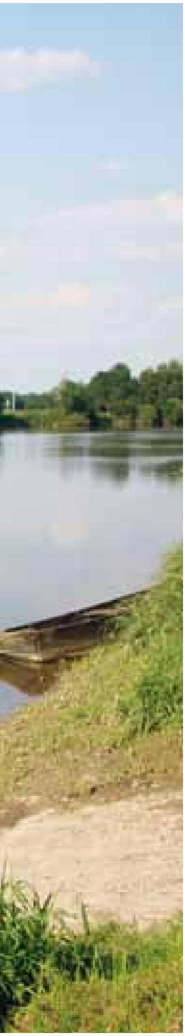
Part II

Contributions to the conference

4

Summary of



4.1 – The valuation of ecosystem services (Jean-Pierre Amigues, INRA, FR)

Concept development

The ecosystem services concept has gained a prominent audience in recent years. Launched by a study by Costanza et al. published in Nature in 1997, which valued ecosystem services worldwide at a rough figure of 33 trillion $ /year, the concept culminated recently in the Nagoya 2010 conference with the official presentation of The Economics of Ecosystems and Biodiversity (TEEB) report, coordinated by the Indian economist Pavan Sukhdev.

Ecosystem Services and water environments

The valuation of ecosystem services for water environments raises two main types of issues. First, there are scientific issues regarding a rigorous identification and definition of these services; the type of spatial entities to be considered in a valuation exercise. Indeed, the ecological originalities of these environments require the careful identification and understanding of the processes at the core of the ecosystem services provided by aquatic life. The strong ecological interactions between aquatic and terrestrial environments complicate defining the right spatial entity and transitions from one habitat to the next. Furthermore, many aquatic ecosystems are highly artificial or already submitted to high anthropogenic pressure, so that “pristine” or “natural” status is difficult to assess. Aquatic environments are also very dynamic and changing (in response to disturbances and biological and hydromorphological processes). One also needs to be careful about value judgments when talking about ecosystem dynamics: for instance is the appearance of new species seen as a biological invasion or as positive evidence of ecological continuity? Secondly numerous methodological issues exist when coming to economic valuation. Valuation is at the crossroad between a supply of services by nature and a demand by users for these services. On the supply side, many ecosystem services are not in direct access to the users and the availability of the service depends upon the existence of infrastructure and therefore of the value of the infrastructure and equipment mobilised in providing the service (e.g. hydropower). Development activities combine several primary services (e.g. sustaining or regulation services in the MEA typology) to provide secondary or elaborated services which are the main objects of value in an economic perspective. But it is difficult to differentiate primary versus secondary services in a valuation exercise. On the demand side, the demand for ecosystems services is dependent on individual and social behaviour. Most valuation protocols in economics are demand assessments, making use of various methods (stated preferences methods or indirect methods). Another challenge is how to account for future generations as well as non-use values, which are difficult to estimate in monetary terms.

Valuation in the decision chain

Valuing ecological services may be intended as a purely informative exercise, the objective being primarily to call the attention of the policy makers and the general public upon the importance of protecting the environment for the benefit of society. In most cases however, the valuation approach should serve operational purposes in the context of local policy actions and priority setting in water management. The valuation of ecosystem services has strong policy implications for the implementation of the Water Framework Directive (WFD) in the European Union. It is expected that a sound application of valuation methods, and especially of economic valuation protocols, may improve the current practice of water managers and contribute to a better recognition of the value of protecting aquatic environments in the public debate.

The risk exists that a lack of dialogue between science and policy may result into a misuse (or an insufficient use) of the valuation approach for decision making. The methodological quality for valuation studies should differ depending on whether strong local policy implications are expected from the study results. Decision makers often have strong expectations from valuation exercises and the reality of the studies provided does not always match expectations.

An efficient use of ecological services valuation is at the crossroads of different issues and challenges both for the scientific communities involved and the water environments managers. The main ones are: dealing with the “long” water cycle challenge, defining the right “ecological entity”, conserving nature as an asset, the supply and demand of ecological services, primary versus secondary ecosystem services and the inclusion of ecosystem services valuation into environmental project management. At a time when managers and stakeholders express strong expectations and a demand for evaluation of environmental policies, ecosystem services valuation has a role for management and policymaking.

4.2 – Introduction on ecosystems services and water management: a manager's point of view (Mark EVERARD, EAEW, UK)

Figure 15. The Mayes Brook before restoration, encased in a concrete channel and mainly screened by a security fence

Historic approaches to water management, as indeed many facets of the environment, have largely been on a discipline-specific basis. The relatively recent emergence of ecosystem services into mainstream European environmental thinking presents an opportunity to deliberate more systemically about the range of public benefits provided by catchments and other ecosystems. This is important as all ecosystem services are intrinsically interlinked, so any intervention has inevitable ramifications for a broad range of stakeholders, many of whom have been historically overlooked in decision-making but all of whom are potential beneficiaries or victims of ensuing management actions. An ecosystem services perspective helps overcome the unintended consequences that have often stemmed from a narrow disciplinary focus, including for example wider biodiversity, water quality and landscape degradation stemming from a narrow focus on food production in land use policy, or the large increases in greenhouse gas generation associated with intensification of wastewater treatment.

Not only does an ecosystem approach better equip us to foresee and avert these problems, but it can also help maximise the range of public benefits potentially stemming from the ways in which we use land, apply technological solutions, direct subsidies and undertake other management interventions.

A range of ecosystem service-based case studies of water systems highlight how thinking at a systemic level may lead to different observations and decisions than those that typically flow from a narrowly discipline-focused approach. It also illustrates how ecosystem restoration, including use of natural processes, tends to maximise value across all ecosystem services.

Ecosystem services are an intuitive way with which people relate to ecosystems. They put the benefits provided by "ecosystems" in terms to which people from all types of backgrounds can relate (food, flood risk, habitat for wildlife, recreation and tourism, etc.) They also help recognise and assess the potential for unintended consequences, a well-understood example being the industrialisation of agriculture to maximise the provisioning service of food and fibre production which has frequently resulted in net cost to other provisioning service such as genetic stock, as well as regulatory, cultural and supporting services. Ecosystem services also help recognise the wider, often unplanned benefits of initiatives, for example as identified in the Tamar 2000 catchment enhancement and the Alkborough Flats coastal realignment case studies, both of which achieved many more outcomes than their initial design briefs by virtue of enhancing natural processes.

The Mayes Brook restoration and associated Mayesbrook Park regeneration project in urban east London used the ES approach to deliver additional intended benefits such as air quality from tree canopies, access, recreation and amenity for people who often lacked gardens, nutrient cycling, habitat for wildlife, flood risk management, carbon sequestration and a range of other benefits.

Defined as they are as the diverse ways people benefit from nature, ecosystem services also help us to recognise the diversity of stakeholders likely to be affected by decisions, and therefore those who should be included in the deliberative process. This in turn can facilitate more effective communication and engagement with people in socially meaningful terms.

Economic valuation of ecosystem services, both monetary and non-monetary, may also have a significant role to play in integrating the natural world and its processes into decision-making, addressing a long legacy of exclusion of many ecosystem services from markets. Bringing ecosystem services into the mainstream of not merely thinking but actual practice requires pragmatic and operationally-appropriate tools. Whilst some new tools may be necessary, a great deal of progress could be achieved by applying the ecosystem services framework to many existing tools (including as examples EIA, SEA, evaluation of the impacts of flood and coastal defence schemes, and broader development planning considerations[31]).

The key benefits of applying an ecosystem approach to water management include recognition of the many values provided by water and aquatic ecosystems within all types of decision-making, and taking account of the many stakeholders (service beneficiaries) inevitably affected by management. Ecosystem services thereby help break down barriers between management disciplines, and between the multiple departments and organisations responsible for them, providing better outcomes for more people and also enabling them better to participate in decision-making.

Insights from the benefits of taking an ecosystem approach to manage coastal realignment and to implement green infrastructures highlight

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[31] UK White Paper June NEA 2011.

some principles relevant to how ecosystem services could be incorporated into Programmes of Measures and engagement processes to implement the WFD. Reconceptualising how the WFD could be more effectively implemented by applying an ecosystem services approach is also informed by two pilot WFD studies undertaken in England. The shift in focus is from narrow compliance with quality standards towards consideration of the many societal benefits for which these metrics are indicators.

Additional water related case studies

TAMAR 2000 (catchment restoration)
http://publications.environment-agency.gov.uk/pdf/SCHO0409BPVM-E-E.pdf

ALKBOROUGH FLATS (managed realignment)
http://publications.environment-agency.gov.uk/pdf/SCHO0409BPVM-E-E.pdf

RIVER GLAVEN Sea Trout Restoration Project
http://publications.environment-agency.gov.uk/pdf/SCHO0110BRTZ-e-e.pdf

Upper BRISTOL AVON Buffer Zone (just 330 metres)
http://publications.environment-agency.gov.uk/pdf/SCHO0210BRXW-e-e.pdf

The MAYES BROOK RESTORATION in MayesbrookPark, East London
http://publications.environment-agency.gov.uk/pdf/SCHO0610BSOW-e-e.pdf

Options appraisal for WAREHAM HARBOUR coastal defence scheme
EFTEC study (see Defra 2007 An introductory guide to valuing ecosystem services)
http://www.defra.gov.uk/environment/policy/natural-environ/documents/eco-valuing.pdf

Five case studies in the EAST OF ENGLAND: Valuing Ecosystem Services in the East of England. Glaves, P., Egan, D., Harrison, K. and Robinson, R. (2009). *Valuing Ecosystem Services in the East of England*. East of England Environment Forum, East of England Regional Assembly and Government Office East England. *(http://www.gos.gov.uk/goee/docs/193474/193503/vesiee1.pdf.)*

The proposed PANCHESHWAR DAM, India/Nepal
http://www.ies-uk.org.uk/resources/papers/pancheshwar_dam_report.pdf

The lessons emerging from these studies suggest that planning needs to expand from individual water body and pressure-by-pressure scales to thinking about strategic interventions at the whole-catchment scale, including measures most likely to deliver a wider range of benefits both geographically and temporally, and to multiple stakeholder groups. Ecosystem restoration is likely to maximise benefits across all ecosystem services categories. There is considerable value to be gained from using ecosystem services as a framework for interpretation of ALL environmental legislation, not just the WFD (in the way the Aarhus Convention applies retrospectively to all environmental regulation to promote access to information and public participation in decision-making).

Current gaps call for a greater number of case studies to learn from; developing better tools for operational use (including retrofitting current tools); revising perverse incentives and reviewing regulations; providing more robust valuations; greater awareness-raising; and a better understanding of how ecosystem services are inter-linked (synergies and antagonisms).

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4.3 – Key factors for successful application of ecosystem services (Jos Brils, Deltares, NL)

Case study

New York city's 9 million inhabitants obtain 90% of their drinking water supplies from the Catskill and Delaware watersheds, situated 130 miles outside the city, which filter water through the ecosystem's waterways and wetlands. Altogether, these regions cover an area of around 1500 square miles and support over 75 000 residents. Historically these watersheds provided very high quality drinking water, but by the late 1980s they became degraded through a combination of land conversion, development and negligence that resulted in sewage and agricultural runoff polluting the waterways. However, instead of building a water filtration plant with estimated construction costs of $6–8 billion (US) and a further $300 million (US) in annual operating costs, the municipal government opted to invest in restoring the Catskill and Delaware watersheds. The cost of restoring the health of these watersheds, and therefore their water filtration services, was only $1– 1.5 billion (US). This decision amounted to investing in natural capital in place of physical capital, with the understanding that if correctly managed the watersheds could provide the same filtration services as the proposed water filtration plant, but for a fraction of the cost. The restoration efforts included rewarding farmers who adopted best management practices, compensating landowners for restrictions on private development and subsidizing improvements to septic treatment systems (Hancock, 2010). In the end, the ecosystem services option came to a 1/8th of the cost of the filtration plant.

This case study generated the following four key lessons for the successful application of an ecosystem services approach.

Key lesson 1: Clear and urgent need for action

To make ESA work, the project should identify a key stakeholder with a clear and urgent need for action. In this case study, NYC was facing a costly drinking water supply issue and needed to consider alternatives to a costly filtration plant.

Key lesson 2: Adopt an entrepreneurial approach

For this, project stakeholders had to leave their own comfort zones comfort zone in order to "learn together to manage together". Both NYC policy makers and farmers joined forces and spent time in mutual education to understand each other's stakes, generating mutual interest in the process and became acquainted to doing business together. This first step resulted in creating a local level partnership. Secondly, it was important that stakeholders looked at the environment as a profit centre, meaning that the correct environmental option would not impose net costs on economic development. They also believed that good environmental status would ultimately produce good water. Some of the savings would also be invested in environmental preservation programmes. Famers effectively became stewards of environmental resources, and environmental measures were designed to benefit farmers economically ("whole farm planning" solution). NYC pays the whole farm planning (WFP) operating costs including the self-selected watershed agricultural council, which provides individual farm support services. Independent academics are in charge of monitoring, research and technical development.

Key lesson 3: Definition of and sticking to clear targets

Together, stakeholders defined a number of clear targets, which they have up to now achieved: the partnership enables the supply of clean raw surface water to NYC which needs no filtration. The minimum membership target (85% farmers join the WFP within 5 years) was achieved ahead of time. WFP proved to be a profitable farming approach.

Key lesson 4: Facilitative leadership

Albert Appleton, formerly Department of Environmental Protection Commissioner and director of the NYC Water and Sewer system, played a major role in the project. He designed and directed the initial implementation of the watershed protection scheme. His character as an entrepreneur who knew how to exploit unrecognised opportunities, as well as being a good communicator and facilitator has much to do with the success of the NYC – Catskill – Delaware project.

4.4 – Case study: Mapping and valuation of water purification services in Europe (Joachim Maes, JRC, EC)

As a service of the European Commission, the Joint Research Centre functions as a reference centre of science and technology for the European Union. Close to the policy-making process, it serves the common interest of the Member States, while being independent of special interests, whether private or national.

The JRC undertook the mapping of ecosystem services[32] at a European scale as the first spatial baseline for ecosystem services. The work comes in support to Target 2 of the new EU Biodiversity Strategy ("by 2020, ecosystems and their services are maintained and enhanced by establishing green infrastructure and restoring at least 15% of degraded ecosystems") and Action 5 ("Member states, with the assistance of the Commission, will map and assess the state of ecosystems and their services in their national territory by 2014, assess the economic value of such services, and promote the integration of these values into accounting and reporting systems at EU and national level by 2020").

[32] See the "European assessment of the provision of Ecosystem Services" report, published in 2011 which presents the first spatially explicit baseline for assessing the state of ecosystem services in Europe.

Water purification is listed among the key ecosystem services provided by rivers, streams and lakes. Water polluted by heavy metals, excess nutrients or pesticides is filtered as it moves through wetlands, rivers and streams, floodplains and riparian zones, and estuaries and coastal marshes.

The JRC undertook an assessment of the contribution of river networks to purifying water through the removal of excess nitrogen from runoff water in Europe. The mapping methodology is based on a catchment specific nitrogen budget model (GREEN) to assess how much nitrogen is retained by surface waters (see figures 16A et 16B). Adopting the Ecosystem Services cascade model (see figure 4), the variables include river systems (structure), denitrification uptake and sedimentation (as processes) and the potential to remove nitrogen from surface waters (function).The benefits on human well-being are the provision of clean drinking water and recreation which can be valued through different methods. The nitrogen loading (drivers) include emissions from households, traffic, industry and agriculture.

Nitrogen loading enhances crop production, coastal fish production and water purification. But it can also result in negative effects such as the provision of drinking water, reduced recreation in and around water and reduction of ecological status. This illustrates the different synergies and trade-offs between ecosystem services and ecological status.

The methodology used contained the following steps:

➡ firstly, quantification of the capacity of freshwater ecosystems to remove nitrogen from surface waters;

➡ estimation of the quantity of nitrogen removed;

➡ assessment of the monetary value of nitrogen removal (using avoided treatment costs through constructed artificial wetlands) and;

➡ analysis of trade-offs between levels of nitrogen loading with ecological status.

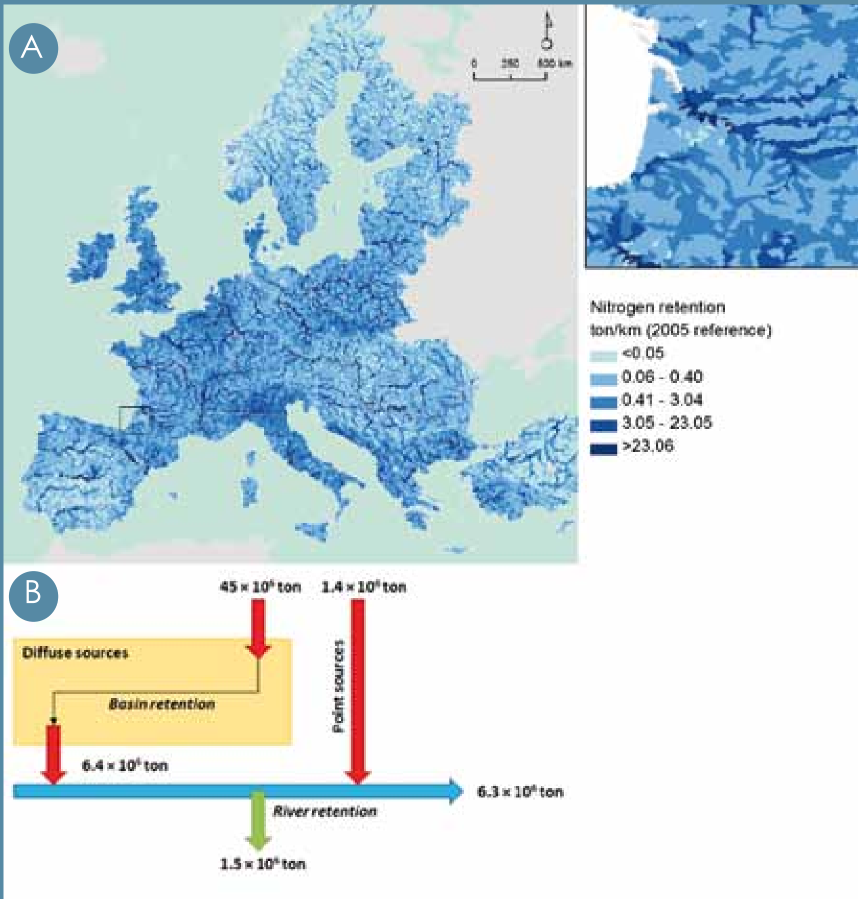

Figure 16 A - Actual nitrogen retention in ton/km of river stretch, (source: GREEN model Grizzetti et al., 2008; Bouraoui et al., 2009)
Figure 16 B - Nitrogen budget broken down over point source inputs, diffuse inputs, catchment-to-river input, river retention and final loading at the outlet, (source: Joint Research Centre – European Commission)

Hydrology and geomorphology at the ecosystem scale both affect the proportion of nitrogen removal. Sources of nitrogen are both from diffuse (mineral fertilizers, manure, atmospheric deposition...) and point sources (wastewater treatment plants, industries, paced areas). Nitrogen retention takes place in the soil, groundwaters and surface waters.

The results of the study show that about 1.5 million tons of nitrogen are removed by rivers per year, which equates to the amount of nitrogen produced through point sources. Rivers and lakes provide at no cost the denitrification service which

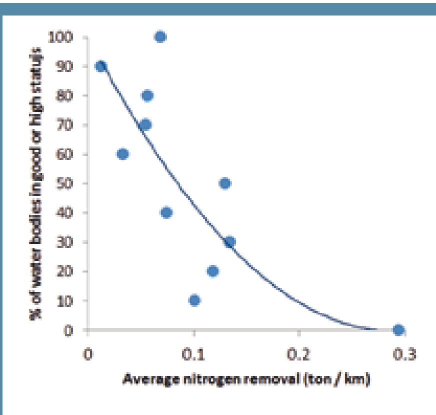

Figure 17. Tradeoff between N removal and ecological status (source: Joint Research Centre – European Commission)

increases the quality of surface waters. The spatial nature of the analysis allows showing where ecosystems gain and loose in terms of delivered services. These benefits tend to be received in downstream areas whereas economic values are generated in upstream areas. This corroborates the observation that values are often generated elsewhere than the areas where benefits are received.

The study also provided insights on the linkages between ecosystem processes and the services provided. The biological processes which increase the capacity of river basins to retain nitrogen seem to include: primary production of nitrogen (uptake of nitrogen by macrophytes and algae in riparian wetlands and floodplains), sedimentation and denitrification. River restoration (e.g. increase meandering) will increase sedimentary environments for denitrification. Figure 17 shows that the rate of nitrogen removal is higher in water bodies with a poor to moderate ecological status.

In conclusion, the concept of ecosystem services can offer added value to water policy at EU scale only if there is explicit consideration of the different synergies and trade-offs between ecosystem services and ecological status.

4.5 – Economic Analysis for Ecosystem Service Assessments (Ian Bateman, CSERGE, UK)

The UK recently completed its National Ecosystem White Paper[33]. The University of East Anglia (UEA) led the economic analysis of the UK National Ecosystem Assessment (NEA) which in turn became the empirical underpinning of the UK Natural Environment White Paper 2011.

The UEA work looked at a variety of ecosystems, including aquatic ones, across time scales, assessing policy, market demand and supply issues and taking natural environment systems into account. The NEA team undertook a data intensive land use modelling exercise from 1969 to today (using data on agricultural land use, livestock numbers, time trends, environmental and climatic data, policy determinants, input and output prices for the period). The resulting models were tested by comparing predictions with actual land use for cereals and temporary grasslands. The models were used to predict climate change impacts on rainfall and temperature and impacts of climate change on land use. The report also provided projections for climate change impacts on land use and incomes by 2050.

Impact of land use on water

The effects of land use change on water are likely to result from changes in nutrient inputs. The impact on the ecological status of waterways can therefore be modelled in an interactive way by varying land use choices (see figure 18). Drivers of water quality include reducing root crops (potatoes, sugar beets), dairy cows, temporary grasslands, suspended sediment, lower water temperature, higher rainfall and increasing river

[33] The National Choice: securing the value of nature, HM Government, United Kingdom, June 2011 in which the UK Government commits to fully consider the value of nature in all relevant Impact Assessments.

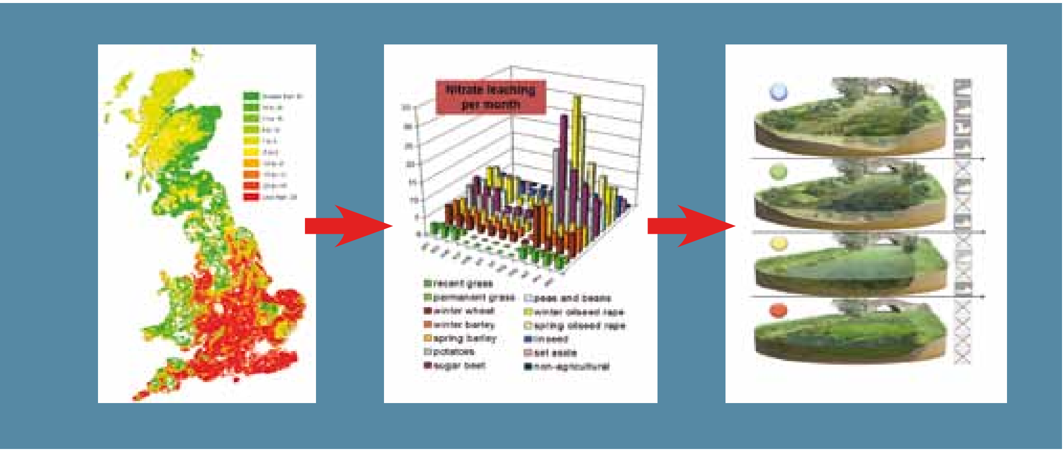

Figure 18. Links between land use change, nitrate leaching and water ecological status (source: Ian Bateman, CSERGE, University East Anglia)

flows. The understanding of the drivers of water quality are important to understand for addressing WFD requirements, better management of treatment costs and forecasting impacts on water recreation.

How to put value on water recreation?

To assess whether the public valued changes in river water quality, the NEA team undertook a household survey in the Leeds/Bradford area to map out where people would go on holiday and related this back to water quality. They also recorded visit frequency and modelled the trade offs between frequency, visit costs and water quality. This provides an estimate on the value that individuals have for changes in water quality (contingency valuation). The results show that people are most likely to visit rivers which are located the nearest to their homes, have a nearby pub, are located far from sewage works, and have high water quality. The willingness to pay for a change in quality ("marginal WTP") is far higher for changes which result in pristine water quality compared to changes which only improved water quality marginally.

Another integrated model was built for the River Aire in the Leeds/Bradford area to assess the costs and benefits for 3 land use changes (20% fertiliser

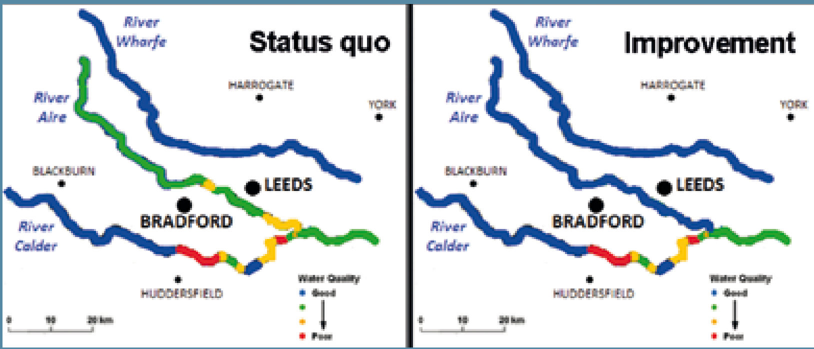

Figure 19. Impacts of land use change on water quality, (source: Ian Bateman, CSERGE, University East Anglia)

reduction, 20% livestock reduction, 20% switching away from arable land). The costs on the rural farming community for the reduction of 20% arable land results in the greatest water quality improvements and benefits to the urban community outweigh the costs on the rural farming community (see figure 19).

Results show that benefits are spatially dependent: concentrate restoration in areas where it is likely to generate most benefits (where most people live).

In conclusion, most of the ecosystem services associated with the water environment can now be valued, and these values vary across locations. Policy makers need to include ecosystem services and need mapping tools to help target policies. Ecosystem services approach helps the targeting of scare resources to high value priority areas. This improves the efficiency of resource use (vital in times of austerity). The ecosystem services approaches emphasis the need for integration between natural sciences, social sciences and decision makers. The valuing nature project intends to unit decision makers and ecosystem service analysts[34].

[34] For more information on this work visit website of Valuing Nature Network.

4.6 – Incentive mechanisms for the payment of ecosystem service: is Full-Cost Recovery the right one? (Antonio Massarutto, University of Udine, IT)

The economic theory has long recognized that the optimal pricing rule for any kind of economic good should be based on the concept of marginal cost, namely the additional cost that has to be encountered in order to provide an additional quantity of the good.

Economics provide three alternative approaches: the Pigouvian approach chosen by WFD to internalise externalities, the Baumol-Oates approach based on the effectiveness of the incentive and the Coasean approach based on achieving optimal level of externalities through direct bargaining among stakeholders via definition of property rights and institutional settings.

Payment for Ecosystem Services (PES) is a sub-optimal solution (as it equates to being a subsidy) which denies the polluter pay principles and has the potential harmful effects of subsidies. The advantage of PES is that it is seen as way to reconcile conflicting water uses ("new urban rural compact") which is a practical tool for bypassing transaction costs and achieve consensus over a cost-effective solution.

When natural resources or other kinds of public goods are at stake, the cost should include not only the financial cost, but also scarcity costs and externality costs; while the presence of positive externalities and public good dimensions should also be accounted for on the benefits side, in order to ensure that the equilibrium generated by the meeting of supply and demand represents a social optimum and not only a private optimum. This rule can also be applied to water. What makes this issue problematic in the water sector, however, is the fact that in most of the cases, water services are based on bulky infrastructure which is characterized by a high one-off fixed cost with very low marginal costs.

In the case of water, ecosystem services cannot be separated from the services supplied by artificial capital and man-made water management systems (infrastructure). Water provides both services to the individual (e.g. supply of drinking water to individual households) and services to the community (since they represent an organized way to access the ecosystem services provided by the natural capital).

Therefore, the appropriate incentive structure should ensure that an adequate effort is put in place in order to develop and maintain the man-made water management system. But how do we share the costs of the water system? This generates sustainability issues: water services should be affordable, but also financially sustainable in the long run bearing in mind that the economic life of infrastructure spans usually several decades which brings in the issue of intergenerational equity. Therefore, we need to be more creative and find ways to develop appropriate management and cost sharing solutions.

While the incentive at the margin has little impact on investment decisions, financial sustainability imposes that the total cost is recovered. Based on this starting point, it is argued that a “decoupling” of cost recovery and economic incentives should be searched for (moving from a Pigouvian to a Boam-Oates approach). There are alternative ways of recovering infrastructure costs than charging a volume charge to users. Indeed cost recovery and financial sustainability can be achieved in principle through any kind of economic instrument, including flat charges, ear-marked taxation or criteria based on social equity; while the economic incentive should be targeted at the effectiveness in promoting the desired behaviour by water users and suppliers of water services, regardless its actual relation with the costs. Furthermore, a number of ecosystem services can potentially generate economic rents over and above normal profits. A portion of the rent should be reinvested into the service protection (e.g. in some countries, licenses for the extraction of gravel are provided on the basis that the industry returns and invests into gravel sand pit restoration).

In recent Italian experience, the Supreme Court has recently prohibited recovering the effluent charge in the water bill for those who are not connected to the treatment facility, on the base that a commercial service can be charged for only when it is actually supplied. In that settlement, the Court considered wastewater treatment as a service rendered to the connected people (rather than a public good represented by a cleaner environment and a more ample ecosystem service). This example shows that how far the discussion on water pricing goes haywire when economic and legal definitions of “cost” and “cost recovery” meet. A solution would be to review the economic principle behind WFD to build practical ways of recovering ecosystem services costs.


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4.7 – What to do when valuation of ecosystem services fails? (Frank Dietz, PBL Netherlands Environmental Assessment Agency, NL)

Cost–benefit analysis (CBA) is a powerful instrument, strongly developed methodologically, especially for the evaluation of infrastructure projects. CBA has since been awarded an important role in the assessment of integrated land-based development. Often, this includes projects carried out under the EU Water Framework Directive. Analysis of such CBAs shows that the empirical basis underpinning the monetisation of nature effects is very weak. On the one hand, the values expressed in monetary terms have often been taken from other studies that show little or no resemblance to the particular project ("benefit transfers").
On the other hand, it is often unclear which citizens are directly affected by the project. Changing the composition of such an impact population may lead to large fluctuations in the measured costs and benefits, while the underlying physical nature effects are not accounted for. The combination of weakly underpinned benefit transfers multiplied by a difficulty to determine the impacted population, provides an end result that is not very informative.

Environmental impact assessments often contain detailed data on expected ecological impacts of the proposed project. This information is not usually used in CBAs, as the impacts have not been aggregated and standardised into easy to use units (e.g. ton/CO_2 eq produced). Ecologists of the PBL Netherlands Environmental Assessment Agency have developed a method for the standardised quantification of nature impacts, in the form of a special Nature Value Indicator (NVI). This NVI has been grafted on the internationally often applied criterion Mean Species Abundance (MSA), as an indicator of ecological quality.

The Species Weighted Nature Value Indicator (NVI^{SW}), or Nature Points, includes a "biodiversity" dimension by weighing ecosystems against each other. The indicator depends on the quality of the ecosystem, the area that the ecosystem covers, and a weighting factor related to rarity of (endangered) species.

This process takes into account the degree to which an ecosystem is of benefit to the biodiversity within a region, country or continent. This enables aggregation of the effects caused by changes to nature areas that have various biodiversity qualities, into one concrete nature figure (similar to DALYs – Disability Adjusted Life Years). Project effects can thus be expressed in so-called nature points, which subsequently may be included in CBAs.

One of the advantages of including nature points in CBAs, is that it shows the trade-offs between changes the project generates within nature and project effects that can be expressed in monetary terms. This improves the comparison of project variants. Because nature points have been constructed from standardised ecological research, comparing projects also has become easier as ratio calculations can now be made. In this way, any costs related to a standardised change to nature – a nature point – become apparent. However Nature Points do not provide insights on the value put by society on nature. It provides insights into the trade-offs between changes to nature and effects in euros.

Improved measurement of nature effects also increases the usefulness of CBAs as supporting instruments in the decision-making process related to projects for integrated land area development. Such improved measurements will possibly bring CBA experts and stakeholders in area development projects closer together. The Nature Value Indicator, namely, suits the knowledge that stakeholders have about effects of planned changes within an area, better than a valuation in monetary terms.

4.8 – Utilizing the ESA for WFD implementation between theory and practice: opportunities and challenges (Eduard Interwies, InterSus, DE)

Challenges

In terms of challenges, many ecosystem services approaches adopt a mere anthropogenic perspective, i.e. the link between the stocks of natural assets found on the systems are connected to the flow of services that provide benefits to human society. Prevalence is given to economic valuation methods, with a main focus on the exchange value of ecosystem services (based on the consumer preferences and the actual use of an ecosystem service). Existence values often are not considered sufficiently.

Measuring and valuing ecosystem services might create the "illusion of precision", when in fact much uncertainty remains. Also we need to be careful when scientific results are translated into policy; there is a risk of oversimplification by using aggregated indicators and economic valuation. For instance, oil extraction in West Africa (as an ecosystem service) does not require functioning ecosystems, so it is misleading to assume that supporting all services translates with maintaining good ecological status. ES valuation should not be confused with estimating the benefits of conservation/ rehabilitation of ecosystems. The same risk applies when translating good scientific results on hydropower production into policy conclusions based on hydropower provision being considered an ES.

Good ecological status may be achieved according to the WFD but does not necessarily mean that ecosystems stability is restored and vice versa. This calls perhaps for a review of the definition of good status linked to the concept of ES.

The scale at which assessments are carried out is also an issue: the WFD adopts a broad base scale which makes it difficult and expensive to assess all ES in a detailed manner.

Way ahead for the next RBMPs according to the WFD

The ESA brings a number of opportunities for WFD implementation. Firstly, it is expected to provide support to the implementation of the WFD-economics requirements, e.g. the issue of exemptions justification. At the strategic level (river basin scale), it could be used for balancing policies and selecting between policy options; at the local level (e.g. group of water bodies) it can help understand specific situations in "hot spots" with societal conflicts or high ecological threats.

Secondly, the ESA could also bring a better understanding of ecosystem functions, processes and interactions (e.g. land/sea transitions).

Thirdly it is perceived as a "linking concept" between

nature protection, water management, energy and other environmental sectors. It can also act as a focal point for linking different environmental policies such as the Marine Strategy Framework Directive and the WFD.

Fourthly, it is perceived as a good communication tool, easier to understand than the partly very technical content of the WFD. It could provide a common language for international coordination on integrated water management. It also has a communication value for discussing effects of measures and feasibility (such as the disproportionality of costs justification for exemptions, article 4 of the WFD) and acceptance with public.

Overall, the ESA does not bring any new fundamental content to modern WFD implementation but it helps focus on what is important and provides a good communication and exchange tool.

4.9 – Case study: Strategy regarding the ecosystem services approach in the frame of 2nd River Basin Management Plan in Romania (Cristian Rusu, Apele Romane, RO)

As part of the first Romanian River Basin Management Plan, the National Administration for Romanian waters sought to analyse environmental costs under the cost recovery requirement of the WFD (article 9). Cost recovery analyses were looked at in detail for wastewater collection and water treatment services. Environmental costs were internalised by integrating the costs related to incoming pollutants in the water resource. However the economic evaluation required by the WFD needs more than financial analysis associated with water supply and waste water treatment. Romania wishes to recover non marketable environmental goods and services too. To do so it should extend to renewable resources which have a market value (such as drinking water, commercial fisheries, biomass, industrial water consumption) and those without market values (climate regulation, hydrological flux regulation, biodiversity, water quality…).

There is a need to link with article 4.4 of the WFD in the case of heavily modified water bodies and costs to recover a healthy ecosystem could be considered as a lost benefit.

Gaps related to Ecosystem Goods and Services

There is an extremely limited number of empirical studies related to the economic evaluation of costs/associated benefits of changes in quantity and quality of water resources and of key services provided by aquatic ecosystems based on conceptual and analytical models. Moreover, there is significant variability of functional and structural characteristics of water bodies and aquatic ecosystems and of river basin characteristics, including community, local and regional economic situation. Finally, one of main obstacles is the lack of information regarding the impact evaluation on the quality of the water resource, on structure and functional capacity of aquatic ecosystems and on the impacts on quality and provision of different ecosystem services.

Application of the ESA

The proposed strategy selected five relevant ecosystem services namely:

- ➡ water purification and waste treatment - total nitrogen;
- ➡ water purification and waste treatment - pesticides;
- ➡ biomass;
- ➡ recreational activities - fishing;
- ➡ biodiversity.

The proposed strategy will be implemented at the scale of the river basin, with river bodies presenting similar characteristics. The aim was to identify a new type of "contribution related to water resource" indicator (for example euro/ ha of restored wetland). Activities undertaken to date include determining part of the environmental costs, defining the scale of analysis, identifying the relevant ES at the river basin scale. The next steps include identifying beneficiaries, valuation of the ecosystem services and promoting Payment for Ecosystem Services schemes in the context of RBMP2.

One proposed valuation method for estimating the supporting services provided by wetlands is done through a case study Ecological and Economical Reconstruction on the Romanian Lower Danube Flooded Plain from the Giurgiu Arges Natural Unit. Based on energy inputs and average prices it has been determined that a cultivated area can be expressed in “equivalent grain acreage” and thus the team was able to deduct the total economic value of a cultivated hectare. The expenditures related to the capitalization of a cultivated hectare (production costs, loss benefits through change of land use from wetlands to agricultural system). The comparative net result is obtained.

ESA and WFD

The ESA will help complete the process for reaching WFD objectives, for instance Article 9 and Article 4 by assessing the total economic value of environmental and resource costs. The programme of measures can be reassessed from a benefit point of view (evaluation of the postponed/foregone benefits). The ESA forces us to rethink participatory processes and ensure that stakeholders are involved.

Payment for Ecosystems Scheme

The floodplain restoration plans saw important opposition from the farming communities and a Payment for Ecosystems Services may be designed as a compensation scheme. First estimates from the PES pilot show that a “healthy” groundwater ecosystem influenced by an ecological agriculture could generate payments to the farmers which will be more cost-efficient for the water authorities than the cost that would have been entailed by water treatment. Even though the quantities of fertilizers (both natural and synthetic) used in Romania are far below those in other EU Member States, the cost of groundwater treatment is in most cases significant.

An evaluation of ecosystem goods and services was carried out analyzing the possibility of benefit transfer based on similar cases and applying the Contingent Valuation method in the frame of a LIFE + Project on a specific River Basin.

Keys for success

Six keys for success were identified:

➡ plan for public awareness actions on the importance of healthier ecosystems and what ecosystem services/payments are. There is an extremely high gap in the field of ecosystem goods and services regarding public and stakeholders knowledge;

➡ identify the focal point of discussion;

➡ establish criteria/elements for the identification of aquatic ecosystems for which the Total Economic Value has to be evaluated applicable to the river basins with similar characteristics (type of water bodies – according to the typology – physical characteristics, social and economical context...);

➡ clarify economic/social aspects related to ecosystem services generated by already healthy ecosystems, as well as services generated once good ecological status will be achieved thanks to the implementation of the Programme of Measures under the River Basin Management Plan;

➡ rank the ecosystems which carried out diverse array of processes that provide both goods and services, on river basin scale. Identify the related goods and services;

➡ promote national legislative framework related to different types of ecosystems and related good and services.

4.10 – Management Strategies for the protection of High-Status water bodies (Bernadette Ní Chatháin, RPS, IE)

Globally aquatic ecosystems are the most impacted by human activities and continue to decline at an alarming rate (Groombridge et al., 1998; Millennium ecosystem report, 2005). This has been reflected in Ireland, through the decline in high ecological status river sites (as defined in the Water Framework Directive), from almost 30% of the total sampled in the 1987-1990 period to less than 17% in the 2006-2008 period. The Irish Environmental Protection Agency's (EPA) long-term monitoring data indicates the numbers of high status river sites has decreased dramatically from 427 to 153 sites assessed (EPA, 2009). The significance of this loss is only realised when spatial analysis reveals that the majority (60%) of remaining sites are located within protected areas associated with human health such as drinking water protected areas, recreational bathing areas and shellfish designated areas, and within protected areas associated with the conservation of habitats and species (Special Areas of Conservation). Therefore, the continued loss of these sites not only represents non compliance with the Water Framework Directive, but also a potential significant loss in biodiversity, while also a threat to human health through the progressive deterioration of our drinking waters, bathing waters and shellfish growing areas.

Given this dramatic decline in high status sites, a desk study project was initiated by the Irish EPA to systematically evaluate the policy and environmental context important for the protection of high status sites. Gaps and limitations of both were identified though a literature review, focussed discussions with key stakeholders, and with international scientists. The desk study focused on the following anthropogenic pressures: land drainage, agricultural fertilisation and forestry conversion.

Key findings were undertaken from the extensive literature review.

In relation with information sharing

➡ the need for better information availability and shared Geographical Information Systems layers among the important players, strengthen Science and Policy linkages (EU INSPIRE Directive 2007/2/EC);

➡ the need for better public awareness of these critical sites (the smallest pressures can impact on high status sites - the input of a few grams of phosphorus, or small increases in silt, hydromorphological pressure or dangerous substances will have a disproportionate impact on a high status system relative to a degraded system - and this concept is difficult to get across).

In relation with government policies consistency

➡ the need for a clear and concise Government commitment to protect and restore high status sites as well as better dialogue and compatible goals across government agencies;

➡ the requirement for more cost-effective mitigation measures and thought for more ambitious ones, such as a national network of high status sites;

➡ the need for new approaches to agri-

© Sylvie Vieillard - Asconit Communication environmental schemes (reform of the Common Agricultural Policy and Rural development programmes), and assessment of the potential environmental impacts of the Irish industry's agricultural policy "Harvest 2020" which focuses on increasing dairy production;

- ➡ the recognition that the Nitrates Directive 91/676/EEC may not be stringent enough;
- ➡ failures: felling of forestry allowed in sensitive catchments without thorough communication between all parties involved, and poor contractor supervision;
- ➡ success story: the Commonage Framework Plans which reduced sheep numbers in sensitive mountain catchments reduced overgrazing pressures and allowed re-vegetation which resulted in better water quality through the reduction in sediment run-off.

The eleven key Directives (Annex VI part A of the WFD) for environmental protection

Bathing Water Directive (2006/7/EC);
Birds Directive (79/409/EEC);
Habitats Directive (92/43/EEC);
Drinking Water Directive (98/83/EC);
Major Accidents (Seveso) Directive (96/82/EC);
Environmental Impact Assessment Directive (85/337/EEC) as amended by Directive (2003/35/EC);
Sewage Sludge Directive (86/278/EEC);
The Urban Waste-water Treatment Directive (91/271/EEC);
Directive concerning the placing of plant protection products on the market (EC No 91/414/EEC);
Nitrates Directive (91/676/EEC);
Integrated Pollution Prevention Control Directive (2008/7/EC).

In relation with a better management of Special Areas for Conservation

- that Ireland needs better protection for our Special Areas for Conservation (SAC) and better selection of SAC sites (the study found very little overlap between high status sites and current SACs, indicating a possible failure of the Habitats Directive Article 17 to select adequate sites);
- recommend legal protection for high status sites outside of the SAC network;
- recommend restoration to build up the national network of high status sites;
- assess the costs associated with the loss of high status sites in terms of loss of biodiversity and costs of conservation measures.

In relation with ecosystem services approach implementation

- the need to integrate the concept into the WFD, especially WFD terminology;
- the need for better understanding of economic values of ecosystem services;
- the need for greater awareness of ESA amongst academic institutions and public sector authorities involved in the implementation of the WFD.

In Ireland, the literature review and the project team's extensive experience of working within the environmental sphere have indicated the clear need for better integration between policies, and within local and national government, to provide a consensus approach for the protection of high status sites and ecosystem services as a whole. Linked inextricably with this are the attitudes of private and public/semi-state bodies to conservation of protected areas, and sites which are targeted for high status. For this reason, it is proposed that a guidance document for local and public authorities be developed to assist these authorities through proposed management strategies and suggested policy changes, to protect high status sites.

4.11 – International biodiversity policy targets and Ecosystem Services (James Williams, JNCC, UK)

Governments of the world agreed upon a Strategic Plan for Biodiversity 2011-2020 (decision X/2), containing the 20 Aichi targets, at the Convention on Biological Diversity's tenth Conference of Parties in Nagoya, Japan, in October 2010. The targets sit under a framework of five goals. The Strategic Plan is a framework for all conventions and stakeholders. In parallel, the EU Biodiversity Strategy was published in May 2011. The EU headline target is "halting the loss of biodiversity and the degradation of ecosystem services in the EU by 2020, and restoring them in-so-far as feasible, while stepping up the EU contribution to averting global biodiversity loss".

The Aichi Targets imply responses at multiple levels, and it is likely that indicators will be developed at global, regional and national scales. The Ad Hoc Technical Expert Group (AHTEG) of the CBD agreed that a framework for communicating biodiversity information should respond to the following questions: is the status of biodiversity improving? (status); what are the implications? (benefits); why are we losing biodiversity? (pressures and underlying drivers); and what do we do about it (responses).

The AHTEG developed a set of 12 headline indicators under which operational indicators were developed, applying the following categories: A - global priority and ready for use (22 indicators); B - priority for development at global level (51 indicators); C – not possible or applicable at a global level but application could be considered at sub-global level. The report and recommendations of the AHTEG should be published on the CBD website[35].

[35] See Subsidiary Body on Scientific, Technical and Technological Advice (SBSTTA) 15 papers INF/6, 15/2 and 15/3.

Aichi target 14 is particularly focussed on ecosystem services[36], but the concept is also explicitly mentioned, or implicit, in others, such as targets 11, 13, 15, and 18. The implementation of the Water Framework Directive is likely to impact on the achievement of a number of the Aichi Targets especially targets within Goal B on reducing the direct pressures on biodiversity and promoting sustainable use (targets 5-10), Goal C on improving the status of biodiversity (targets 11-13), and Goal D on enhancing the benefits to all from biodiversity and ecosystem services (targets 14-16). Multiple metrics will be needed to evaluate WFD effectiveness e.g. to measure reduction of pollution, sustainable production of food, and the cultural importance of water bodies. The extent to which these issues may be measured directly, or through proxies, is a subject for debate.

Reference documents on valuing ecosystem services are available. The RUBICODE[37] project for instance looked at the state of ecosystem services of rivers and lakes at EU scale. The UK NEA looked at freshwater, wetlands and floodplain environments. Metrics for provisioning services are common, and mapping and modelling tools have been developed[38].

The Water Framework, Habitats, Birds, and Marine Strategic Framework Directives are major policy instruments for improving the status of biodiversity, and for delivery of ecosystem services.

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[36] Target 14: “By 2020 ecosystems that provide essential services, including services related to water, and contribute to health, livelihoods and well-being, are restored and safeguarded, taking into account needs of women, indigenous and local communities.”

[37] RUBICODE Coordination Action Project (Rationalising Biodiversity Conservation in Dynamic Ecosystems) was funded under the Sixth Framework Programme of the European Commission (Contract No. 036890). Identifying and prioritising services in European terrestrial and freshwater ecosystems.

[38] See CBD technical series publications: “Developing ES indicators” Experiences and lessons learned from sub global assessments and other initiatives.

4.12 – Water Management Policy: 2012 Blueprint to Safeguard Europe's Waters (Jacques Delsalle, DGEnvironment, EC)

Since the adoption of the Water Framework Directive in 2000, EU water policy has made another step change by taking an integrated approach on the basis of the concept of river basin management aimed at achieving good status of all EU waters by 2015. However, as pointed out by the European Environment Agency's 2010 State of the Environment Report, the achievement of EU water policy goals appears far from certain due to a number of old and emerging challenges. The 2012 Blueprint to Safeguard Europe's Waters will be the EU policy response to these challenges. It will aim to ensure good quality water in sufficient quantities for all sustainable and equitable uses. The time horizon of the Blueprint is 2020 since it is closely related to the EU 2020 Strategy and, in particular, to the EU Resource Efficiency Roadmap published in 2011. The Blueprint will be the water milestone on that Roadmap. However, the analysis

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underpinning the Blueprint will cover a longer time span, up to 2050, and will drive our policy for a longer period.

To achieve this ambitious objective, the Blueprint will synthesise policy recommendations building on four on-going assessments:

➡ the assessment of the 2009 River Basin Management Plans delivered by the Member States under the Water Framework Directive;

➡ the 2007 review of the EU action on Water Scarcity and Drought;

➡ the upcoming assessment of the vulnerability of water resources to climate change and other man made pressures (due in 2013) and;

➡ the Fitness Check of all EU water policy instruments in the framework of the Commission Better Regulation approach.

The outputs of these reviews, together with a large number of studies launched by DG Environment, DG Research and Innovation, the Joint Research Centre, the European Environment Agency and others, will provide an outlook on the sustainability and vulnerability of EU water resources and provide the knowledge base to develop the policy options that can deliver better implementation, better integration and completion of EU water policy.

The Blueprint framework follows the DPSIR (Drivers, Pressures, State, Impact, and Response) framework. It builds on a number of land and water use scenarios and identifies variables which influence water resources. It will develop a catalogue of adaptation and mitigation measures based on an optimisation model and include an overview of co-benefits, cost, effectiveness and integration criteria as well as critical success factors. Indicators on water retention, savings, recycling and quality will be presented. The next policy options will be presented in a Communication scheduled for November 2012.

Specific focus will be given to land management to see what measures could be widely implemented in the EU and the policy instruments that can accelerate their implementation, in particular water-related green infrastructure measures such as reforestation, floodplains restoration, soil management, and sustainable urban drainage systems.

In addition to integration of such measures into the Common Agricultural and Cohesion Policies, the European Commission will develop a methodological framework for the wider application of payments for ecosystem services. This is a key tool missing to alleviate the failure of the market to duly account for such services and its application can create important economic incentives for water and biodiversity protection.

In terms of links with ecosystem services the Blueprint will provide an overview of the state of ecosystems and their capacity to supply services. Measures being looked at include indicative targets based on the maximisation of net social benefits from water use.

Ecosystem services approach is a relevant policy instrument: it provides a link between ecological status and services. Ecosystem services need to be better integrated into cost benefit analysis, water pricing, cost recovery and to assess agricultural measures. Ecosystem services can also be taken into account for setting targets for water resources protection at the river basin level.

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5 Summary of


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5.1 – Roundtable 1: Ecosystem Services, water scarcity management and flood protection

Key issues relevant to WFD objectives and the theme

Water quantity issues are not adequately tackled in the WFD which is mostly quality oriented as clearly depicted by the RBMP assessment. Droughts are mentioned in the exemptions article, and drought management plans as supplementary measures. While flood issues have been addressed through the Floods Directive which addresses issues of vulnerability and flood risks, relevant issues on water scarcity and drought remain unsolved. In 2007 the European Commission published the communication on water scarcity and drought indicating the way forward and follow-up reports. The 2012 Blueprint will address some of the current implementation issues; however the question on the need of a relevant directive/legislation for water scarcity and drought remains pending.

One of the main questions is whether the ecosystem services approach can address issues of flood and drought management and, vice versa, whether our current water regulation and natural hazard regulation approaches impair the natural capacity of ecosystems to fully provide their services.
The ESA helps us recognize the relationships between stocks of natural capital, such as land and water, and the services that they provide to support human prosperity and wellbeing.

Droughts and Floods disrupt these relationships, altering the flow of services to society. Droughts for example have negative effects on a range of ecosystems services, namely "provisioning" services (such as food production and water supply), "regulating" services (such as local climate and hydrological processes), "cultural" services (such as heritage, landscapes, and amenity) and "supporting" services (such as natural habitats and soil formation).

Can an Ecosystems Services framework help qualify the magnitude of impacts attributable to droughts and floods, and provide a basis for economic valuation, assess the social, geographical and temporal distribution of impacts, and identify major sources of uncertainty and vulnerability? Could such a framework be used to inform cost-effective policies on drought management, recognizing that a precautionary approach is required where data and methods are not able to provide robust economic assessments?

Economic valuation of dike relocation in the German Elbe

Background

The case study focuses on the morphological changes of rivers in Germany


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which have been changed considerably by diking over the last two hundred years. The resulting changes of water quality have not been dealt with systematically in the German Programme of Measures of the Water Framework Directive, mostly due to cost considerations, with the exception of fish passability. The relocation of dikes constitutes another option to improve the morphological quality of river water bodies and therefore constitute a measure of flood protection. In the past, the construction of artificial storage with the inclusion of polders were considered to be more effective from a flood control perspective without taking into account the additional benefits of dike relocation in comparison. The debate between dike relocation proponents and dike strengthening/controlled storage methods is very topical especially since the 1992 Elbe floods.

Funded by the German federal government, the case study presents a cost-benefit analysis of a dike relocation programme in the German part of the Elbe, between Dresden and Geesthacht, compared with an equivalent of construction programme. In applying a total economic value approach, the study looked at the ecosystem functions and services provided. It compared different options: dike relocation with the creation of polders, and a multifunction land use option such as controlled "ecological flooding").

Ecosystem Services Approach

A number of models were created to simulate the effects of each artificial flooding events for each of the options (hydraulic model to compare overflow capacities with current levels, nutrient discharge modeling, damage assessment modeling).

Three types of ecosystem services were selected for the evaluation:

➡ changes in flood protection (benefits measured through avoided property damages; costs include investment costs, rehabilitation costs, maintenance costs, opportunity costs of agricultural and forestry land),

➡ changes in wetlands biodiversity (used benefit transfer from 28 European studies based on willingness to pay studies near riverine wetlands) and;

➡ nutrient retention of wetlands (calculations based on replacement costs, using the MONERIS model on nutrient discharge and retention).

The benefits from these changes of ecosystem services as a result of the relocation programme are then compared to the cost of both alternative programmes.

Results

The comparison shows that the dike relocation programme is more economically advantageous than the polder programme if one includes the two additional ecosystem services. The study however did not include indirect effects of dike relocation (and requires detailed ecological modeling with vegetation growth and hydromorphological changes). Results were disaggregated per 50km river stretches in order to visualize benefits on a map. This provided information to the governance structure (Bundesländer) on who bears costs/reaps benefits from different options. The results helped discussions between environmental protection organizations and NGOs and local authorities but didn't influence measures in a global way. Only three local sites were selected for implementation as financing remains an issue.

Key lessons

In terms of scientific lessons, the economic valuation allowed the comparison of alternative strategies for flood protection in a multifunctional manner. It enables to take nature protection objectives into account. Dike relocation can be assessed through an ecosystem services approach. To do so, it was important to quantify the biophysical effects of measures and translating them into benefits. Additional research is needed to include carbon sequestration and recreation into the valuation. This valuation was made possible thanks to the availability of a large scale hydrological flooding model.
In terms of policy lessons, ecosystem services are a convincing and practical concept to structure multifunctional aspects. Dike


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relocation is an economically worthwhile option to improve the morphological quality of lowland water bodies. The spatially explicit identification of changes within the biophysical realm and land-use changes are important for policy makers. Including uncertainties is critical for the estimates of quantities and values.

Management of climate change impacts on the Veneto – Friuli water system

Background

The TRUST Project (Tool for Regional scale assessment of groUndwater STorage improvement in adaptation to climate change) is funded by the 2007 LIFE Plus Environment Policy and Governance Program of the EC and by the Italian Ministry of Environment, Land and Sea. TRUST aims specifically to study the water resource status and availability in the North East Alpine District.

The TRUST project aims to incorporate climate change scenarios in the River Basin Management in accordance with WFD[39] and examine issues related to the development of water management strategies at River Basin scale (WFD) in relation to the climate change scenarios.

[39] Article 4 of WFD 2000/60/CE which states that *"Member States shall protect, enhance and restore all bodies of groundwater, ensure a balance between abstraction and recharge of groundwater, with the aim of achieving good groundwater status".*

Ecosystem services approach

The hydrogeologic reservoir allows the storage and the release of water into glaciers, lakes, springs, rivers, groundwater bodies and soils. This service guarantees water supply for human activities and it has a social and economic values. The NE Alpine system is yet extremely vulnerable to adverse impacts of climate change and to management and water use. In the last 30-40 years the water table has slowly but progressively decreased, numerous wetlands have been desiccated (straining the resurgence ecosystem and its biodiversity) and the aquifers have been depressurized, also in relation to the overexploitation.

Results

The advanced application was developed specifically to simulate water deficits affecting summer crops in the Veneto Friuli Plain. The TRUST project developed a Tool For Modeling Water Balance, able to characterize all the physical processes and variables playing in the Alpine district water ecosystem service and able to estimate the climate change impacts on the hydrogeological balance and water reserves feedings, from mountain basins to irrigation networks. The TRUST modules are based on complex geodatabases including climatic and hydrological data (rainfall, snow, temperature, humidity, wind, river flows, hydrometric levels, etc), geological and groundwater data (wells water levels, pumping rates, aquifer permeability, etc), land use and agronomic data.

An innovative catchment scale hydrological surface model was developed on a mountain basin scale, coupled with two different IPCC scenarios of the CMCC climate model. The hydrological model reproduces the potential effects of climate on the hydrological cycle of the investigated basins. A regional quantitative groundwater status model was elaborated at a large scale starting from a geo-statistical reconstruction of ground waters.

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The water balance tool is a predictive GIS tool including the previous models and analyses factors affecting the hydro-geological balance linked to the decline of aquifer levels. It includes hydrological scenarios, land use evolution and future water demand, actual groundwater extraction, water demand for irrigation and control of aquifer recharge, as well as anthropogenic variables affecting the water demand increase.

The project then tested different types of natural sites for artificial aquifer infiltration effectiveness including a forested area, grassland and uncultivated land.

Key lessons

The TRUST modelling tool allows to evaluate for homogeneous hydro-geological areas the effectiveness of practices (such as artificial Managed Aquifer Recharge – MAR) to protect and restore the quantitative groundwater resource. Forested areas promote greater water infiltration and groundwater recharge, removal of nutrients from water and production of wood biomass. Groundwater recharge and woodchip revenue could be included in a payment for ecosystem services scheme where farmers are compensated for foregoing their usual crops for fast growing woodchip species in exchange for the improved groundwater infiltration.

Discussion

What is the knowledge on ecology and functioning of ecosystems required to implement ESA?[40]

The second case study undertook direct field work for testing three types of vegetated sites for groundwater infiltration. The site with greatest yields (water volumes infiltrated/hour) was uncultivated land, followed by grassland and finally forested lands. The second case study highlights the benefits of water infiltration (nutrient removal, utilisation of effluent from biogas plants, production of wood chips, biodiversity gains).

ESA is useful for understanding the impacts of floods on life and ecosystems. The ESA perspective helps to analyse ecological flows in drought analysis.

There is generally a good understanding of aquatic ecosystem functions (for example "this river provides denitrification at the rate of x kg of NO_3 removed per km^2"), the difficult part is to identify the service and see how it impacts on human well-being. Additional fundamental research in this case is not necessary but the need is to translate this knowledge into ecosystem services and make cause-effect linkages between ecosystem functions and services.

It would help to have ES indicators on water quantity and quality, in relation with ecosystem dynamics, resilience and thresholds. They would play a role similar to the carbon taxation system (CO_2 teq). There is research on nutrient economic markets and scientific literature exists on this topic. It will be important to translate it into water policy.

Does the maintenance/ enhancement of these ES contribute to reaching WFD objectives and vice-versa?
ESA can support ranking and selecting measures, identifying acceptable tools and justifying exemptions. ESA has a role to play in analysing trade-offs in situations of competing demands. ESA can support the WFD programmes of measures (e.g. Elbe case study) by providing an appraisal of the optimal flood protection measure from an ecosystem services provision point of view.

In terms of water quantity, the strategies developed in both case studies are outside the RBMP and are not relevant to WFD. Reaching WFD objectives has a lot to do with biological status whereas providing ES in this case has more to do with morphology. The main knowledge gaps are the linkages between morphology and biology. The ESA should provide a good indication of trade-offs for different good status objectives, however the issue is that exemptions are provided in the WFD and this provides an incentive not to optimise the provision of ES. The issue is also that exemptions are difficult to justify.

Most of the RBMP measures are quite vague. The ESA could help present measures on specific issues.
Some see the ESA as a way to justify "business as usual", others see it as a risk for making new demands in terms of environmental protection and ensuing costs.

What are the relevant spatial, economic and policy, scales and frameworks, in relation with RBMP?
For flood control, to really understand the importance of potential of sets of measures, the river basin scale is a good scale to apply the ESA.
Floods and droughts should be thought and addressed at the basin scale.

The water quantity/quality appreciations remain a local

[40] All rountables were asked to discuss the questions in italic type.

issue (in comparison with climate change). Research gaps remain on how to aggregate water quantity/quality consideration at the global level beyond a river basin scale. The WFD is implemented at the river basin scale: water resources are assessed at basin level and are influenced by different land uses. ESA is applied mostly at the local scale but how do we implement it at basin scale?

ESA helps highlight potential trade-offs and for instance justify which of the policy frameworks (Natura2000, CAP and WFD) are most consistent with ecosystem services provision.

Has the use of ES allowed a better understanding of water management issues in connection with WFD implementation?
This question is important from a scientific as well as policy viewpoint. ESA can support the understanding of linkages between water and other policies (spatial planning, agriculture).
In the German case study, hydromorphology is one of the key driving factors of the river basin status. However the WFD does not impose meeting good status on morphology. Nevertheless, cost-effectiveness in achieving WFD objectives are influenced by morphology.

What does valuing ecosystem bring in WFD economics context? What are the scientific constraints to its feasibility?
In the Elbe case, the full monetary valuation was carried out to appraise options and identify which one optimises ecosystem services provision. In some cases monetary valuation is carried out, in others this is dangerous, so the ESA concept is an alternative.

Policy and operational conclusions

How can ESA provide new operational tools, or fit in existing ones?
This question is relevant in relation with WFD economic analysis and public participation components.
In the first case study, the economic valuation allowed the

integration of multifunctional effects of restoring wetlands as an option to improve morphological quality of water bodies. Talking of ecosystem services is a convincing and practical concept to structure a multifunctional problem. The spatially explicit differentiation of benefits and costs stretched along the river basin is key information for policy makers.

ESA supports interdisciplinary research and provides a common language. ESA can support the categorisation, selection of measures and justify exemptions. ESA has highlighted that hydromorphology is key as it impacts on water quantity, although not considered as a WFD quality status requirement.

What are the remaining knowledge gaps and research needs?

➡ How to identify and settle trade-offs between different stakes in situation of competing demands?

➡ Lack of knowledge regarding spatial and time aspects of ecosystem services supply. How do we assess dynamics between different ecosystem services?

➡ Lack of knowledge regarding the contribution of ES to human wellbeing;

➡ Rather than focusing on additional research on the bio-physical aspects of ecosystems (processes and functions), further research is required on qualifying the linkages between ecosystem functions and services provided.


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5.2 – Roundtable 2: Ecosystem Services, water quality management and diffuse pollution protection

Key issues relevant to WFD objectives and the theme

Previous to the WFD implementation, a more fragmented approach to water management was applied, often focusing on chemical quality standards, while the ecological "health" of the system was not in the centre of attention. Water condition and quality was usually assessed based on punctual estimations of chemical indicators and integrity. The innovative aspect that this Directive brought was an explicit consideration of ecological health and setting of specific and integrated "good status" objectives, the conceptual integration of several categories of factors, like system characterization, pressures and impact assessment, or management scenarios (interdisciplinary and complementarity) (Blancher et al., 2011).

Provided one can describe, if not quantify, the link between ecosystem integrity and good status, and ecosystem integrity and the provision of ecosystem services, the ecosystem services approach could provide a very relevant tool to reinforce the knowledge on relationships between Good Ecological Status (GES), biodiversity and ecosystem's services.

The following case studies illustrate success stories for reducing agricultural pollution into surface waters by testing Payment for Ecosystem Services schemes.

The Waternet case study in the Netherlands

Background

The levels of nitrates in the groundwater around the farmlands near Amsterdam are above water quality standards. All agricultural plots are below sea-level and the water system is strongly influenced by high levels of nitrates and phosphorus (mainly through peat). Reducing the use of manure alone would not achieve the required results so the Waternet water board sought to cooperate with these farmers in 2009. 24 farmers received payments by the water board to take measures that go further than what they already have to do by law by creating wet buffer strips along the farm plots.

In the Netherlands most farmers are members of the "Agriculture Nature Union". These associations of farmers and citizens have a long tradition of protecting grassland birds as a form of ecosystem service. Cooperating with these associations gives the possibility to introduce other ecosystem services in a very cost effective way. The ANV field agents act as intermediaries between farmers and the waterboard.

The waterboard is testing a cooperative partnership with farmers to improve water quality in order to reach WFD objectives at a lower cost. The water board sets a


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minimum amount of ditches to deepen to create nature friendly watersides. The aim of the case study is to assess the costs and benefits of nature friendly riversides in terms of ecosystem services provision including water purification services.

Ecosystem Services Approach

Farmers on the project were required to dig out and maintain ditches to create so called "nature friendly banks", fish friendly diver tubes to stimulate fish migration, "blue corners" and deeper ditches than usual to give fish the chance to hibernate. The water board promotes these measures to contribute to a better water quality in the main water system as an alternative for undertaking works in the main system itself (which will be costly as banks are typically made of concrete or wood). The use of the terms "ecosystem services" was not mentioned specifically, farmers were asked to contribute solving the water quality problem by improving biodiversity. The waterboard enters into payment contracts with farmers in exchange for their collaboration. Farmers are compensated financially for the digging works, loss of earnings, management costs and fencing costs.

In 2010 and 2011 a large monitoring programme was carried out to get insights into the costs and benefits of the measures undergone by farmers.

In the project there is an extra incentive to participate: farmers may fill up small ditches to

facilitate manoeuvring with their tractors as a compensation for the fact that they have created nature friendly banks. In this way farmers create a much better infrastructure on their farms: they now get longer plots that are much easier to farm on.

Results

In total, 24 farmers created 20 km of "nature friendly banks", which is much more than the water board projected to achieve. The process involved 48 "kitchen table" inventories with farmers on the type of activities that could be carried out. The farmers are very enthusiastic about this new way of cooperation, and the way the banks enrich their farmland. The banks function as a kind of "high pressure cooker" for biodiversity. They can bring back typical agricultural area and red listed birds (e.g. the skylark and godwit). The waterboard is also satisfied as it enables to achieve WFD objectives with less resistance from farmers and at a lower cost.
One of the farmers made on his own initiative some grass snake breeding nests. He re-used the grass clipping from the banks to build those nests. The water board originally planned breeding nests at another location, but the locations chosen by the farmer worked even better. For both parties this was a typical win-win situation.

Lessons

The reason for farmers to join the project is not motivated by income (as farmers are compensated for the loss of agricultural land) but by the desire to enjoy more nature on the farm, "closing of the circle of minerals and nutrients", enhancing biodiversity, and the structure of the farmland plots.

Local and regional governments and farmers can use ecosystem services as a common tool and language to achieve more green and/or blue elements in the mono cultural landscape with less resistance and more participation. One of the next steps is how to integrate these results with the application of CAP 2013.

Paying farmers for better water quality of the River Tamar in South West England

Background

The "Upstream Thinking" initiative was originally conceived as the result of "lateral thinking" by the Westcountry Rivers Trust Project Team - all of whom recognised that society places huge demands on landowners in our rural catchments. Not only do we require them to produce food from their land, for which they get paid, but we also ask them to deliver a number of services from their land for which they do not get paid. These services include the provision of clean water, the protection of biodiversity, contributions to flood defences, the management of landscape character and accommodation of recreation and access. Therefore, one may not be surprised that these land managers often struggle to deliver all of these services to the level required by society.

The objective was to deliver a fully functioning Payment for Ecosystem Services scheme on four river catchments. The local private water company provided funds through the West Country Rivers Trust to farm businesses to improve raw water quality in the catchment rather than fund post abstraction filtration.

Ecosystem Services Approach

The water purification service was monetised and used to develop a market to compensate farmers for undergoing alternative practices.

South West Water have recognized that it is cheaper to help farmers deliver cleaner raw water (water in rivers and streams) than it is to pay for the expensive filtration equipment that is required for them to treat polluted water after it is abstracted from the river for drinking. South West Water also believe that water consumers will be better served and in a more cost-effective manner if they spend the money raised from water bills on catchment

restoration in the short-term rather than on water filtration in the long term. They anticipate that, through this proactive rather than reactive approach, they may be able to reduce the future additional costs of water purification by a factor of fifty and so ultimately save their customers from footing the bill.

Measures included:

- ➡ riverbank fencing, to prevent lameness, straying and infection of cattle, resulting in a saving of £400 per year for a 200 head dairy unit and which covered the cost of fencing in the first year (£250);
- ➡ collecting and using roof water in the farm yard through gutters resulting in a saving of £360/ year for a 600m^2 roof producing 720m^3 water for a slurry pit.

Results

It took the project one year, three advisors and 50 farmers covering an area of 40 km^2. It is estimated that the entire Upstream Thinking initiative will cost each water consumer in the South West around 65p per year.

What makes the project even more beneficial is that, in addition to improving raw water quality, there are likely to be a wide array of additional benefits. First, the beautiful natural landscape of the West Country, which is highly valued by many residents and visitors alike, will be protected and restored on an unprecedented scale. Second, the work will reap huge rewards in the conservation of biodiversity on the land and in our rivers and nature conservation will become an integral part of the living working landscape once again, rather than the exclusive preserve of protected nature reserves. Finally, farmers will, as a result of the project, be paid fairly for delivering not just food from their land but also a wide variety of other essential services for the benefit of society as a whole. In this project it was not seen helpful to provide many quantification details on ecosystem services, and information was kept at a strategic/global level.

Lessons

In this case study, a non-profit organisation acted as a broker to prevent dominance of a market driven ecosystem services. Good cost benefit evidence is required (although perfect numbers are not required). Third sector local delivery is cost effective. A strategic "ecosystem services plan" is needed for each catchment which can be quantified and monetised if needed to build a strong case for implementing the PES scheme. The strategic plan needs to include regulatory aspects and not just delivery of payment details.

Discussion

There is already considerable experience in applying pollution mitigation approaches to farming practice to enhance water quality and associated ecosystems. Both case studies applied some "good practice" principles.

Does the maintenance/enhancement of these ES contribute to reaching WFD objectives and vice-versa?

Yes, however, the WFD was designed to synthesise and integrate data and information at the river basin, country and EU levels; it is not able to be used as a planning or diagnostic tool for a local issue. Some of the most important parameters that influence the ecology are missing in the WFD. For example the effects of sediment pollution are not directly identified. There is still an emphasis on old fashioned conservation - i.e. nature is failing so we manage nature directly. We are beginning to realise that nature is failing due to human pressures and the way to manage land use can include markets and economics. ES give us the opportunity to communicate scientifically and economically with people and generate better conditions for the environment. Internalising the costs of ecosystem degradation to avoid the impact in the first place is now possible through PES schemes.

What are the relevant spatial, economic and policy, scales and frameworks, in relation with RBMP?

As differing Ecosystem Services are delivered at differing scales, it does not make sense to choose either a local or global scale; the key is to show the interlinkages between the different scales.

A plan at the scale of a catchment (catchment plan) should be produced with guidance derived from national principles - e.g. level of food independence required, climate change predictions and scientific evidence. Financial beneficiaries from the implementation of the catchment plan should join together. A group PES approach can then be delivered through an essential intermediary – a broker. National taxation fills in gaps when ES are not marketable. Individual assessments at the sub-regional scale are essential.

Has the use of ES allowed a better understanding of water management issues in connection with WFD implementation?

The entry point of both case studies shows that the water companies initiated a payment for ecosystem services with farmers in order to improve water quality at a lower cost than traditional “end of pipe” treatment. The improved biodiversity results in the Dutch case study supported the evidence that restoring water banks was beneficial to biodiversity as well as water quality improvement. Another driver for promoting the supply of ecosystem services is the general public who might wish to see the return of an iconic species (such as the freshwater pearl mussel). Using flagship species is a good communication tool for mobilising public support.

Both case studies supported the idea that the environment can be a profit centre and that multiple benefits can arise from ecosystem services provision, but economic incentives are needed to enable farmers to break even. Better environmental management practices were adopted. The rate of mobilisation can be quite fast but the issue is then how to scale-up to the river basin scale.

What does valuing ecosystem bring in WFD economics context? What are the scientific constraints to its feasibility?
In both cases, no specific valuation was carried out as it did not seem relevant to farmers. There is no need to undertake a detailed economic valuation if stakeholders do not expect or demand it.

Policy and operational conclusions

How can ESA provide new operational tools, or fit in existing ones?
The WFD requires adequate cost-recovery and taking into account the polluter pays principle. However, the comprehensive analysis of cost-recovery is difficult. The WFD promotes the inclusion of social, environmental and economic effects in cost-recovery calculations. The ecosystem services approach could help in overcoming difficulties related to the cost-recovery issues.

The success of both case studies has much to do with the language used in communicating with farmers. Although an ecosystem approach was used, the term "ecosystem services" was not used, as scientific concepts and statistics are not the best way to convey messages to farmers. Moreover, the attitude of the authorities and water companies changed from a regulator to that of enabling partnerships.The ESA is slowly producing a paradigm shift towards a more systemic approach to managing ecosystems. Even though a piece of land may be private, it generates ecosystem services for a range of beneficiaries.

There are a range of good case studies where the ESA may have worked, however we cannot expect a "one size fits all" solution and great flexibility is required in applying the approach.

The Commission needs to recognise the limitations of the WFD as a reporting structure. To get effective delivery a different tool is needed such as rural spatial planning based on "aspirational" ES delivery. WFD was designed before this paradigm shift developed. It can still work as an upwards reporting mechanism but it would be distracting and even damaging to try and use it for delivery. At local levels, local issues can, and should, dominate.

What are the remaining knowledge gaps and research needs?
Ecosystem services can demonstrate why good ecological status matters, it helps people become aware of services provided by nature. However, that has a lot to do in terms of environmental education; for instance the difference in concepts between polluter pays and provider is paid. Moreover we need to decipher what is desirable from a human welfare point of view.

A better understanding of cause-effect relations are needed between project activities and impacts on ecosystem services and good ecological status. Markets should eventually be created to promote the provision of a range of ecosystem services if we can show that these

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will have a positive effect on ecological status.

Cost benefit studies for externalised costs of food production would be very valuable. We pay a high value for our food but currently we pay little to the producers who farm in a damaging manner; in addition we pay for the clean-up and to Europe for the subsidy. We would like to pay the producers more to farm better and avoid the externalised costs and associated problems like WFD failure.

Can ESA provide articulation with other policies (energy, agriculture)?

The link is the integrated spatial planning tool based on “aspirational” ES delivery towards which all funding and regulation should focus.

EU policies and directives should be clarified regarding their key messages on ecosystem services. Does WFD become the tool for ecosystem services delivery? How does it potentially clash with other directives?


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5.3 – Roundtable 3: Ecosystem Services, maintaining and restoring good hydromorphological status

Key issues relevant to WFD objectives and the theme

Human development activities have severely affected the hydromorphology of our water bodies. Impacts on hydromorphology are often irreversible, permanent and profound and not only immediately and in the direct vicinity but may occur also far outside the time and space scale of the pressures that generated them.

The concept of heavily modified water bodies (HMWB) was introduced into the WFD in recognition that many water bodies in Europe have been subject to major physical alterations so as to allow for a range of water uses. These specified uses tend to require considerable hydromorphological changes to water bodies of such a scale that restoration to "good ecological status" (GES) may not be achievable even in the long-term without preventing the continuation of the specified use. The concept of HMWB was created to allow for the continuation of these specified uses which provide valuable social and economic benefits but at the same time allow mitigation measures to improve water quality.

It is acknowledged that a river in good hydromorphological status (geomorphological processes in a dynamic equilibrium) promotes and supports good ecosystem functioning and the good ecological status. Therefore, many of the measures to restore or maintain good ecological status are linked to hydromorphological aspects (particularly to geomorphological aspects). Whereas the WFD requires water quality to be good everywhere, hydromorphological status on the other hand needs to take into account tradeoffs between ecology and socio-economic functions. The latter may result in the designation of water bodies as heavily modified (HMWB) with hydromorphological conditions thus differing from near natural ones that a good ecological status cannot be reached. HMWB is a trade-off term used to allow physical changes to water bodies that support human use and cannot be made undone without losing infrastructure (e.g. embankments for flood protection or regulation of rivers for navigation).

The efficiency of any programme of measures, particularly in river restoration, requires a good knowledge of hydrological, geomorphological and ecosystem processes and of their interrelationships. It also raises the need for tools to make stakeholders understand the complexity and values of these processes and of the services they deliver despite anthropogenic pressures on rivers. These tools and new knowledge can help inform policy choices and make them more participative, shared and accepted.

Many past and ongoing experiences at the EU level both from science and policy side can be exploited or

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communicated to support the understanding of the benefits of HYMO processes such as the CIS ad hoc HyMo Working Group; the FP6 Ecoflood project; IWRM-net FORECASTER; FP7 projects; the ECOSTAT ad hoc group on hydromorphology and the GEP etc.

Dordogne River and Hydromorphological Good Status

Background

The presented case study derives from the ESAWADI project (an IWRM-Net 2 funded project).

The Dordogne basin is a rural, agricultural and forested region, with many tourism activities thanks to a rich natural and cultural heritage. Water-based activities (fishing, recreational boating…) are very much developed on the river and on the upstream hydro-electric dam reservoirs. Since the 2nd World War, the hydraulic and ecological system of the Dordogne River has been deeply modified due to the construction of hydro-electric dams, which result in sudden variations of water levels and temperature in relation to dam operations. This situation has been worsened by mineral extraction in the flood plain. Since the beginning of the 1990s, an integrated water management policy was implemented in the Dordogne basin under the governance of a Regional Public Watershed Board (EPIDOR). Nevertheless, the pressures on the river morphology are still high. For instance, some flood protection practices are maintained in spite of their negative impacts on ecosystems.

Within the WFD implementation context and the search for good ecological status of water bodies, river dynamics, and particularly the river's capacity of shifting its course naturally, can have a tremendous impact on the Dordogne ecosystem functioning. Indeed, the identification of significant water issues within the framework of WFD implementation confirms that most of the downgrading factors depend on river's physical status.

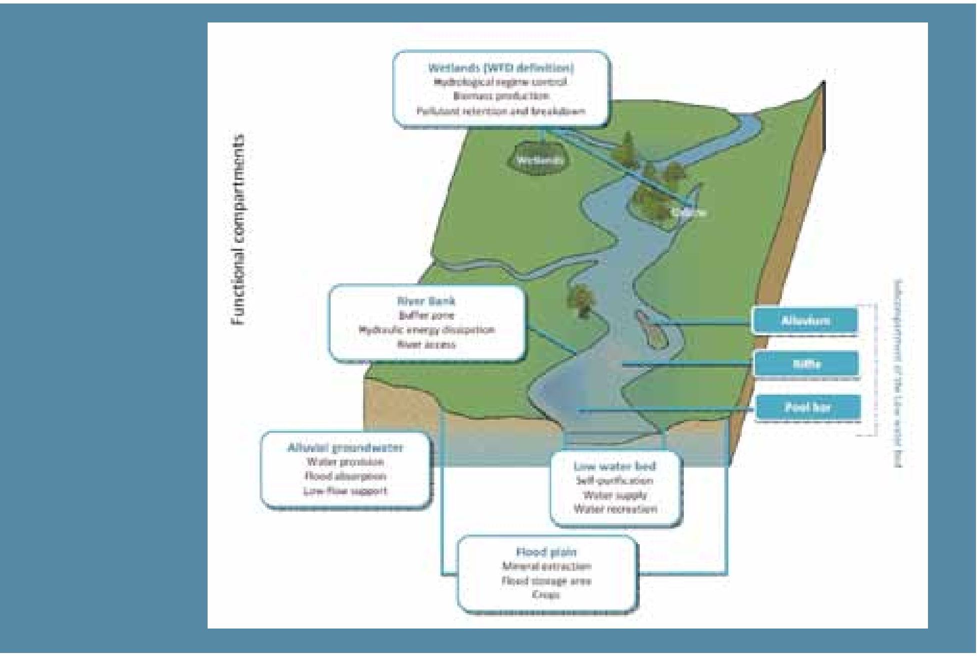
Many regional (such as Adour-Garonne Water Agency and EPIDOR) and local structures have to find solutions to achieve good ecological status of water bodies by 2015. The case-study deals with the hydromorphological status of the middle stream of the Dordogne River between Argentat and Limeuil (approximately 120km), where the river channel dynamics are still strong and where the river basin management plan has to be implemented.

The project is based on the assumption that ESA could be very relevant to assess the benefits of water management measures aimed to improve the hydromorphological status and thereby convincing the different stakeholders of the relevance of these measures.

Ecosystem Services Approach

The project aims firstly to provide a good description

Figure 20. River ecosystems (source: Elise Catalon, Asconit Consultants)



of the relations between ecological functions, based on a good geomorphological status, and services important to stakeholders; and secondly to provide quantitative indicators to evaluate the importance of the services (monetary values can be provided if relevant but not systematically). The assessment of processes underlying ecosystem services should result from an agreement among scientists and stakeholders given that strong scientific legitimacy can not be expected from the ESA. The project team works with closely with EPIDOR (Regional Public Watershed Board), the Adour-Garonne Water Agency, and the Onema regional office to implement the approach jointly; a questionnaire and local workshops are planned in 2012 for local authorities, farmer representatives, and tourism sector representatives. To date, the project undertook a detailed context analysis of water body status, local uses and practices, key issues; identified broad ecosystem services in the study area; developed an assessment framework based on the relations between river functional compartments (see figure 20), ecosystems and ecosystem services (see table 4) and drafted a questionnaire for understanding relations between riparians and hydromorphological issues[41]. The next stages include the selection of priority ecosystem services and scale, indicators and quantification of services and stakeholder participation in the process.

Results and lessons

From a policy point of view, the project elicited very high interest and expectations from both EPIDOR and the Water Agency, who are dissatisfied with traditional economic evaluation and who need to convince stakeholders to implement the measures required to improve the geomorphological status.

[41] For more information refer to Blancher, P. et al. (2011).

Table 4. List of the ecosystem services identified

Selection of ecosystem services		
Provisioning[42]	**Regulation**	**Societal**
Professional fishing	Auto-purification of water	Landscape (aesthetic value, support for artistic inspiration)
Water supply for domestic use	Biodiversity and ecosystems preservation	Biodiversity, social and heritage value
Water supply for agricultural uses	Prevention of bank erosion	Leisure fishing and hunting
Cattle watering place	Prevention of floods	Tourism and fresh-water activities (bathing, boats…)
	Drought impact mitigation	
	Regulation of local climate	

From a scientific perspective, the development of the evaluation methodology itself was very interesting to go deeper in the scientific issues and raise questions related to the link between good ecological status (sensu WFD) and ecosystem functioning.

Measuring trade-offs between hydropower and alpine river ecosystem services

Background

Hydropower generates 84% of the electricity produced from renewable sources in EU15, i.e. the 15 first members, 19% of the total electricity production in the whole EU25. However hydropower generation can disrupt the river continuum, affect the natural zonation of habitat change, induce interruption of vertical groundwater recharge and reduce natural flood regulation. The RES-e Directives[43](20/20/20) require enhancing renewable electricity sources but, at the same time, the Water Framework Directive obliges Member States to reach or maintain good ecological status in water bodies, intrinsically limiting the hydropower exploitation. Mountains administrators face an increasing demand of water abstraction daily but lack reliable tools to rigorously evaluate the effects of abstraction on mountain rivers and the longer term impacts on energy supply and socio-economic benefits. Understanding the relationship between biodiversity and an ecosystem's integrity is essential for the management of natural resources and ecosystem services.

The presented case study derives from the ongoing SHARE project[44], aimed to develop, test and promote

[42] Hydroelectricity which is very important in the upstream part and has strong impact will however not be considered as an ecosystem service. On the contrary, we shall try to assess the increase in ecosystem services related to a loss of production implied by measures good for the geomorphological status.
[43] Promotion of Electricity from Renewable Energy Sources (RES-E).
[43] For more information visit website.

a decision support system (DSS) to combine river ecosystems services and hydropower requirements. It is managed by the ARPA Valle d'Aosta - Regional Environmental Protection Agency of Aosta Valley in Italy and includes partners from Italy, France, Austria, Slovenia and Germany. It is co funded by the European regional development fund in the context of the 2007 – 2013 European Territorial Cooperation Alpine Space programme.

Ecosystem Services Approach

The project is based on the assumptions that:

- ➡ understanding the relationship between biodiversity and ecosystems stability on longer time scales is essential for the management of natural resources and their services;
- ➡ a Multi-criteria Analysis (MCA) can be used as a "trade-off" tool for evaluating conflicting river management alternatives. The project involved public administrators and planners (at the regional level) of mountain areas dealing with rivers hydropower exploitation aspects.

The methodological core of the project is the application of the Multicriteria Analysis (MCA) applied as a tool for assessing trade-offs between conflicting river management alternatives, defined by different criteria detailed by indicators. This approach is being led using existing scientific tools, adjusted to transnational, national and local norms and carried out by a permanent panel of administrators and stakeholders. For each alternative scenario, a total performance score is calculated using the MCA which takes into account the effects of each management alternative on the specific river system. Decision makers are helped to identify the most sustainable alternative using an interrelated set of weighted indicators tailored towards each specific case requirements. This MCA approach will be tested in 11 pilot case studies. The methodology is based on a range of ecosystem services quantification methods (Cost-Benefit Analysis; Simple

Additive Weighting SAW; Multi-Attribute Utility Theory MAUT (Keeney and Raiffa, 1976); Simple Multi-Attribute Rated Technique SMART (von Winterfeld et Edwards, 1986); Analytic Hierarchy Process – AHP (Saaty, 1980).

A feedback collection process was initiated using online seminars and web questionnaires. The list of ecosystem services considered is presented in table 5.

Lessons

The provisional key lessons for policy are:

➡ multi criteria approaches can be used as a quantitative way to consider different ecosystem services provided by mountain rivers, even without monetising values;

➡ hydromorphological indicators can support a robust "ESA-based planning" for integrated river management.

Benefits for science are that WFD indicators can be fully used in MCA however those indicators based on biological communities appear not to respond to hydropower pressure in mountain rivers while hydromorphological indicators are particularly fitted to represent ES exposed to hydropower exploitation pressure.

From an operational side, the presented MCA is a free support for decision making and can be customised to different rivers and management contexts. A project software is already available (beta version only). The criteria used reflect different stakeholders needs and viewpoints. Weight assignment to the different criteria is a strategic (political) choice. Different

Table 5. List of ecosystem services considered

Selection of ecosystem services		
Provisioning	**Regulation**	**Societal**
Fresh water provisioning	Extreme hydrological events regulation	Recreation
Habitats for species & genetic diversity	Waste water treatment support	Tourism
Minor nutrient cycling	Local climate regulation (big dams).	Aesthetic appreciation
		Spiritual experience
		Educational values

weights can be attributed to the same criteria and indicators in different environmental conditions. Indicators are derived from a range of information sources (e.g. law, euro values, expert-based qualitative assessment). The WFD community based indicators have to be supported by hydromorphological indicators. The SHARE MCA can support both local hydropower assessments and strategic planning.

Examples of other river-based research case studies using MCA:

➡ canton de Fribourg: Evaluation and management of the hydroelectric potential –MCA based on Exclusion criteria & Evaluation criteria, ongoing;

➡ provincia Verbano Cusio Ossola: MCA applied to ex ante hydropower plannification, ongoing;

➡ etats généraux de l'Eau en Montagne – 3rd International Congress of integrated water management in high watersheds, Mégève 22–24/09/2010 (several French stakeholders involved), ongoing;

➡ progetto TWOLE: a MCA based system for plannification and management of water resources to manage usage conflicts, Regione Lombardia, 2008;

➡ demands for a Changing World – International Conference and Exhibition: MCA applied to maximise hydropower potential and economic and social benefits while reducing environmental impacts, Lisbona 27-29/09/2010;

➡ land of Tyrol (AT): Criteria for HP exploitation.

7th Geomorphololgy and Gravel-bed River workshop

The 7th GBR workshop took place on 8th September 2010 in Tadoussac, Canada[45]. The intent of the workshop was to produce tangible outputs in order to place a value on geomorphology-related ecosystem services.

A guided discussion and role play was set up amongst the geomorpholgists attending. The audience was split into river system beneficiaries (including farmers, electricity companies, extraction companies, commercial fishing companies, drinking water companies, property owners, rafting, recreational fishermen, photographers, transportation companies). Together they produced a set of parameters affecting ecosystem services (see table 6).

Results

Channel and floodplain morphology (including lateral and longitudinal connectivity) and sediment transport regime (including amount, timing and size) are considered key geomorphological characteristics necessary to support many of the final ES identified as "consumed" by the beneficiary groups.

Discussion

In general it can be stated that there was a strong consensus among the 27 participants that the ESA can be very helpful to identify and communicate the benefits of hydromorphological processes and patterns for ecosystem functioning and services. Conceptually, the ESA is very much in line with the overall spirit of the WFD. At the same time the ESA is more holistic especially when compared the way the WFD

Table 6. Parameters affecting ecosystem services

Selection of ecosystem services				
Quantity	**Quality - Physical**	**Quality - Chemical**	**Quality – Biological**	**Quality – Landscapes**
Amount (water) Timing (water) Amount (sediment) Timing (sediment)	Temperature (water) Conductivity (water) Clarity (water) Flow velocity/turbulence Bed substrate Suspended sediment load (floodplain) Channel morphology Stable bed Stable banks	Dissolved oxygen Chemicals Odor	Pathogens Ecosystem health/biotic integrity Fish Wildlife Plants Genetic diversity	Aesthetics

[45] For more information see: Bergeron et al. (2012).

is implemented. For a well-balanced trade-off between conflicts and benefits the ESA has more to offer than the WFD in a strict sense, which may overlook essential elements.

The various comments given on the key issues are presented below in bullet form. Time did unfortunately not allow discussing whether there was agreement or disagreement on all of these comments. So the individual comments should be used as issues to take forward, but cannot to be interpreted as a consensus of the group.

What is the knowledge on ecology and functioning of ecosystems required to implement ESA?

Rivers are more than riffles and pools, especially in mountain environments. We need to include and quantify geomorphologic processes too. It is particularly key to assess the natural geomorphologic arrangement and the consequences of various human interventions. We have to understand the physics of rivers before we can understand how they affect ecology.

Sediments are a vital part of the ecosystem, up to now their dynamics and continuity have been neglected by WFD evaluation tools, differently from biota and water. Sediment dynamics affect the entire river basin evolution down to the beaches and coastal environments.

There is a need to develop appropriate tools for river condition assessment which are based on a sound geomorphological approach and on understanding river processes. The lack of specific consideration of channel processes and trends of channel changes is probably the main limitation of existing methods, which are therefore poorly suited to an understanding of pressure-response in the context of rehabilitation actions[46].

A sounder knowledge and consideration of river physics might help us overcome the inconsistency between biological and hydromorphological indicators. Ecosystems may have been assessed to be in a good ecological status, while their hydromorphological conditions are not good. Greater scientific knowledge on HYMO – BIOL interactions is needed.

Does the maintenance/ enhancement of these ES contribute to reaching WFD objectives, and vice versa?
The holistic spirit of WFD is very much in line with ESA. Problems stem from the way WFD is implemented. Most countries do not measure GES properly, because they do not address hydromorphology adequately (e.g. in the UK during the designation phase, HMWBs - Highly Modified Water Bodies - have seen their number reduced because they reached GES).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[46] Exceptions are the River Styles Framework developed in Australia, the Scottish MImAS (Morphological Impact Assessment System) developed by the Scottish Environmental Protection Agency, the French SYRAH (*Système Relationnel d'Audit de l'Hydromorphologie des Cours d'Eau,* Chandesris et al., 2008) and the system recently developed in Italy for stream morphological evaluation named IDRAIM (system for stream hydromorphological assessment, analysis, and monitoring - Rinaldi et al., 2011).

If strictly implemented, the WFD assessment system may neglect hydromorphology and its fundamental supporting role, because hydromorphology is used in the WB classification only to confirm the high biological status. However in Scotland it is also used to confirm the good status.

For HMWBs, ESA may prove very relevant to assess GEP (Good Ecological Potential), in a site specific alternative approach. It may turn out to be a much better approach than conventional methods.

The ESA approach seems to be particularly consistent with a sound hydromorphological assessment aimed at restoring or maintaining good ecological status.

What are the relevant spatial, economic and policy, scales and frameworks, in relation with RBMP?
In many cases stakeholders are overwhelmed by information in River Basin planning, in some cases totally saturated. ESA at the local scale worked fine in several situations, whereas at a wider scale it may present severe difficulties.

ESA may help focus on the issues that really matter. If restoration is only carried out at the local scale, its effects are limited. The catchment overlay is governing the result.

ES leads to multilateral decision making, because all the stakeholders are invited around the table

Has the use of ES allowed a better understanding of water management issues in connection with WFD implementation?
Socio-economic development has brought us far from nature. Most people live in cities. ESA helps us rediscover we still have a link with nature. ESA contributes to give HYMO its fundamental role back, highlighting the role of sediment dynamics, through what could be called a cultural revolution.
Applying ESA teaches us how we interact with the environment. ESA helps

to look at all the possible benefits. ESA integrates and leads to better decisions also at a broader spatial scale. ESA gives a value to less visible aspects.

It is a good framework to organise the discussion and involve stakeholders. ES links ecology with economy, but also links science, policy and stakeholders.

ESA seems to be a very useful method for communication. ES is a good concept to convince people of the need to maintain natural processes which support certain ES. It is good to start from ES stakeholders perceptions and values. Other directives need to embrace ESA as well.
The PIANC (The World Association for Waterborne Transport Infrastructure) is embracing the concept of ES and is producing good practice documents for navigation: ships have to be adapted to rivers, and not the opposite. But within navigation there are progressive and rather traditional groups.

However an ESA process-based approach to enhance the ecological status in large rivers is still lacking. ESA is considered highly relevant for large rivers of which most are HMWBs. For example, the re-introduction of the salmon (flagship species) in the Rhine was a result of improving ES in the Rhine catchment.

What does valuing ecosystem bring in WFD economics context? What are the scientific constraints to its feasibility?
ESA helps to establish an overview of the issues at stake, whereafter the most significant issues can be valued. ES are a tool to integrate the different values society gives to the environment. You cannot value everything, but monetary evaluation should be carried out anywhere is reasonable (especially to include management costs and use values into a Cost Benefit Analysis).

We should not be afraid to use an environmental economic approach. It should be seen as a process, especially when trade-offs are concerned, and not only a case of putting figures against environmental values. An ESA results in a more multidisciplinary approach including social and economic sciences. Through valuing you may get insights for benefits and losses elsewhere.

Policy and operational conclusions

How can ESA provide new or fit in existing tools for achieving WFD objectives? (public participation, economic analysis, pricing), identification of operational tools (communication, incentives)…The WFD can benefit from the ecosystem services approach, which is more holistic than WFD because:

- it also considers semi-aquatic and terrestrial components that WFD only addresses if they regard protected areas;
- ESA takes into account processes more than forms or structures, so favours an enhanced ecological assessment;
- listing ES helps stakeholders to identify all relevant goods and services associated with the different measures which can be implemented.

What are the remaining knowledge gaps and research needs?

In total there are 81 INTERREG projects and 172 LIFE projects dealing with flood management, integrated river basin management, river floodplain restoration, water quality improvement projects but there is no synthesis of all these experiences.

There are a number of projects working on the theme of hydromorphology (IWRM-net FORECASTER looking at the ecological effects of hydromorphology degradation and positioning hydromorphology in river rehabilitation strategies). Nevertheless, some research gaps still remain, as underlined during the discussion, and they regard mainly:

- the knowledge of river geomorphological processes (including sediment dynamics);

- the development of appropriate tools for river condition assessment (and measures efficiency evaluation) which are based on a sound geomorphological approach and on understanding river processes;
- the knowledge of different process-induced river morphological features (especially in mountain environments) and consequent habitats in order to better understand and evaluate the ecological processes.

Can ESA provide articulation with other policies (energy, agriculture)?

ESA strengthens awareness of this articulation since the improvement of the provision of an ecosystem service may rely on WFD as well as other policies (e.g. Energy Directive, Floods Directive).

6 “Blue River Restoration”


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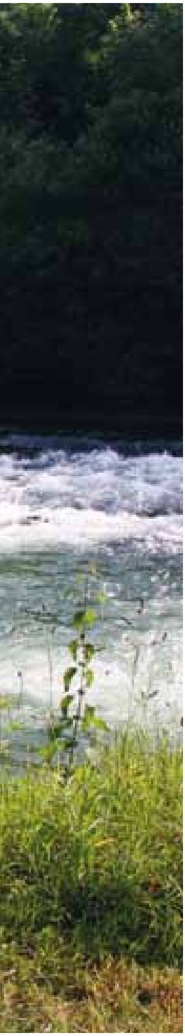
role playing game



Background

The PSI – Connect project ("Policy-Science Interactions: Connecting Science and Policy through Innovative Knowledge Brokering in the field of Water Management and Climate Change") is a collaborative project funded by the EC Framework Programme 7. Within the project Role Playing Games represent one of the knowledge brokering instruments that are developed and tested in real-life policy situations. Role Playing Games are used to model complex processes and relations between actors and they serve as an instrument to better understand the roles and positions of the actors involved in a process as well as the complexity of the issues addressed in the game. The goal for all participants is to take a particular role, address the issues defined in the game and experience the effects of their decisions and actions.

Depending on the purpose of a role playing game it can resemble real-life situations to a certain extent or be executed at a more abstract level. Role playing games are therefore a learning experience that fosters better understanding of complex problems through active participation in a system less complicated than the real world, but with enough of its characteristics to provide a rich experience. In this way a safe learning context is created encouraging experimentation (see PSI-Connect Factsheet on "Simulation Games" by S. Döpp; available online).

Objectives and game features

The objective of the Role Playing Game was for participants to develop an understanding of how the concept of ecosystem services can be applied within water policy and how to evaluate trade-offs in river catchment management. In the game participants were engaged in identifying and "trading" ecosystem services within the context of river restoration. In the roles they played they experienced first hand how trade-offs need to be negotiated and how this can help to evaluate alternative options to achieve policy goals.

After a short introduction the participants were equipped with all the information they needed to play their roles during the 60-minute game. This information included general instructions, confidential individual role descriptions, as well as supporting materials such as maps, tables, and a list of ecosystem services.

The game was titled "Blue River's Restoration" and Ecosystem Services in "Blue Province" and involved five different parties:

- ➡ Office of the Governor of Blue Province (OGBP) – chairing the meeting;
- ➡ Blue Tourism Association (BTA) - representing the interests of tourism-related businesses in the region;
- ➡ Blue Management Authority (BMA) - the government agency responsible for the implementation of the EU's Water Framework Directive seeking to achieve good ecological status;
- ➡ Blue City Municipal Office (BCMO) for Healthy Working Rivers – looking for ways to reduce Blue City exposure to floods;
- ➡ Blue Farmers Association (BFA) - advocating continued social and economic importance of farming in the region.

The Governor of Blue Province called for a meeting to discuss the pressing issues evolving around the Blue River, which is of low ecological status and unattractive for most of its length. Even though the problems have been known and discussed for many years river restoration projects have not taken off yet for various reasons. The governor wants to overcome the differences and wants to find out if the concept of ecosystem services can help the decision-making in the Blue River region. Together with the key stakeholders key ecosystem services are to be identified and trade-offs to be discussed. The aim of the meeting is to agree on an outline for “a way forward” drafting an integrated research plan to address the most pressing questions that will help them to make evidence based decisions about how to invest in the region.

Results and participants feedback

A small but nonetheless diverse group representing governmental and non-governmental organisations as well as science took part in the role playing game session forming one group. The levels of previous knowledge about ecosystem services varied from none to very well-informed. Independent of the background and level of ecosystem services knowledge and experience all participants were able to fully engage in the game. For some participants it was easier to adapt to the situation of the Role Playing Game than for others but everyone was immersed in his or her particular role after a certain time. Each role had its own challenge and the players reflected on their struggles.

Overall, the participants agreed that they learned something about ecosystem services. Those with no or little previous knowledge about ecosystem services had gained an understanding of the wide range of ecosystem services that exist and an insight into the complex interrelations and trade-offs. This also sparked interest in wanting to learn more about ecosystem services. Those with previous knowledge emphasised the new way of understanding the various perspectives on ecosystem services through experiencing these in the game. Using the concept of ecosystem services was deemed to be a strong tool for stakeholders in river catchment management leading to a new approach of communicating with each other. However, challenges are seen in the next step of how to implement ecosystem services and tackle the issue of payments.

Conclusions

To round off the Role Playing Experience the final discussion focused on two key questions, for which the following conclusions were formulated by the group:

What can we learn for the implementation of the WFD?
We learned from this game what ecosystem services are.
Using the concept of ES is:
➡ goal-oriented;
➡ more practical than existing approaches;
➡ supporting bottom-up approaches;
➡ arguably more stake/stakeholder inclusive than other existing approaches;
➡ system-oriented;
➡ asking for tailor-made solutions requiring flexibility.
Overall it was concluded that ES can help formulate research questions, forcing those involved to think out of the "water box".

What does this mean for the use of scientific information?
It is clear that dealing with uncertainty is a major challenge. Figures and reliable results are needed to "sell" the concept of ecosystem services to decision-makers. Yet, a high level of uncertainty remains and dealing with this is all the more difficult the higher the costs are.
Therefore it is important that research questions need to be formulated in a joint effort to pave the way for thinking out of the "water box".

Quote from participant:
"I enjoyed it very much, and had fun. The virtue of the game is that it produced a simple setting easy to start playing. However we found it difficult to wear different hats. I am a researcher dealing with research questions all the time. The important lesson for me is that other partners are not familiar with research. Ecosystem services provided a common language to communicate better."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Part III

Annexes

Benefits transfer

A practice used to estimate economic values for ecosystem services by transferring information available from studies already completed in one location or context to another. This can be done as a unit value transfer or a function transfer. (OECD glossary of statistical terms).

Ecological services

Services which rely on functional biological processes (as defined by Amigues et al., 2011).

Ecosystem Approach

A strategy for the integrated management of land, water and living resources that promotes conservation and sustainable use in an equitable way. The application of the Ecosystem Approach will help reach a balance of the three objectives of the Convention on Biological Diversity: conservation, sustainable use and the fair and equitable sharing of the benefits arising out of the utilization of genetic resources (CBD, 2000).

Ecosystem services

The direct and indirect contributions of ecosystems to human well-being. The concept "ecosystem goods and services" is synonymous with ecosystem services (TEEB, 2010b).

Ecosystem Services Approach

An Ecosystem Services Approach provides a framework by which ecosystem services are integrated into public and private decision making. Its implementation typically incorporates a variety of methods, including ecosystem service dependency and impact assessment. These methods are often applied at a watershed or landscape level and frequently involve projecting a decade or more into the future. The

Glossary of terms

Ecosystem Services Approach builds on the Ecosystem Approach developed under the Convention on Biological Diversity, but further emphasizes ecosystem services as the link between ecosystems and development (UNEP, 2007).

Environmental costs

defined as representing the costs of damage that water uses 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 salinisation and degradation of productive soils - WATECO Glossary of terms.

Environmental services

Services which originate from the physical structure (minerals, transportation) but are not dependent on biological processes (as defined by Amigues et al., 2011).

Good Ecological Status

For surface waters, Good Ecological Status (GES) is defined relatively to several biological elements (typically algae, macrophytes, macro-zoobenthos and fish), and, to a lesser extent, to hydromorphological and physico-chemical quality elements. The anchor point of the WFD is that the bio-assessment tools developed using these biological quality elements must be defined relatively to reference conditions (i.e. conditions observable in pristine sites or least anthropogenically-disturbed sites), which allows a comparison of the GES at the European scale through an obligatory intercalibration process. For groundwater, the approach is that of the precautionary principle. It comprises a prohibition on direct discharges to groundwater, and (to cover indirect discharges) a requirement to monitor groundwater bodies so as to detect changes in chemical composition and to reverse any anthropogenically induced upward pollution trend. Taken together, these should ensure the protection of groundwater from all contamination, according to the principle of minimum anthropogenic impact (WFD Glossary).

Resource costs

Defined as the costs of foregone opportunities which 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 - WATECO Glossary of terms.

Acronyms

AHTEG	Ad Hoc Technical Expert Group of the Convention on Biological Diversity
CAP	Common Agricultural Policy of the EU
CBA	Cost Benefit Analysis
CBD	Convention on Biological Diversity
DG ENV	Directorate General Environment of the European Commission
DG R&I	Directorate General Research and Innovation of the European Commission
DPSIR	Drivers, Pressures, State, Impact, and Response
EIA	Environmental Impact Assessment
ES	Ecosystem Services
ESA	Ecosystem Services Approach
ESAWADI	Utilizing the Ecosystem Services Approach for Water Framework Directive Implementation
EU	European Union
GES	Good Ecological Status
GEP	Good Ecological Potential
GIS	Geographical Information System
HMWB	Heavily Modified Water Bodies
HS	High Status
HYMO	Hydromorphological
JRC	European Commission Joint Research Centre
MCA	Multi-criteria Analysis
MEA	Millennium Ecosystem Assessment
MSA	Mean Species Abundance
NEA	UK's National Ecosystem Assessment
NVA	Nature Value Indicator
NYC	New York City
OIEau	International Office for Water
Onema	French National Agency for Water and Aquatic Environments
PES	Payment for Ecosystem Services
RBMP	River Basin Management Plan
SEA	Strategic Environmental Assessment
SME	Small and Medium Enterprise
SPI	Science Policy Interface
TEEB	The Economics of Ecosystems and Biodiversity
UEA	University of East Anglia, UK
WFD	Water Framework Directive
WFP	Whole Farm Planning approach promoted under the NYC case study
WTP	Willingness to Pay

Catskill and Delaware watersheds restoration	www.nycwatershed.org, refer to Part 2 Section 4.3
DSS Elbe	Economic valuation methods for the Decision Support System for the management of the Elbe river basin, http://www.landschaftsoekonomie.tu-berlin.de/menue/research/projects See Part 1 Section 2.2 and Part 2 Section 5.1
ESAWADI	EU FP7 IWRM-Net 2 project on Ecosystem Services Approach and Water Framework Directive, refer to Part 1 Section 2.1 and Part 2 Section 5.3
EURECA	European Ecosystem Assessment as a follow-up to the MA by 2015 http://biodiversity.europa.eu/ecosystem-assessments See Part 1 Section 3.2
FORECASTER	Knowledge and information system relating hydromorphology and ecology of European rivers http://forecaster.deltares.nl/index.php?title=Forecaster See Part 1 Section 3.2
IMPACT	Developing an Integrated Model to Predict Abiotic Habitat Conditions and Biota of Rivers Application in Climate Change Research and Water Management http://www.impact.igb-berlin.de/background/iwrmnet See Part 1 Section 1.3
INQUEST	Interdisciplinary quantitative ecosystem services team http://www.valuing-nature.net/projects/inquest see Part 1 Section 3.2
InVEST	Integrated Valuation of Ecosystem Services and Tradeoffs http://www.naturalcapitalproject.org/InVEST.html See Part 1 Section 2.3
IWRM.-NET	Integrated Water Resource Management project within the European Research Area (ERA-Net) with a focus on the Water Framework Directive http://www.iwrm-net.eu/
MA	Millennium Ecosystem Assessment http://www.maweb.org/en/index.aspx See Part 1 Section 1.1

List of projects

Mayesbrook Park regeneration project	http://www.naturalengland.org.uk/regions/london/ourwork/integratedprojects.aspx See Part 1 Section 2.3 and Part 2 Section 4.2
NEA	UK National Ecosystem Assessment 2011 http://uknea.unep-wcmc.org/ See Part 2 Section 4.5
PSI-CONNECT	Connecting Policy and Science through Innovative Knowledge Brokering in the field of Water Management and Climate Change http://www.psiconnect.eu See Part 2 Section 6
RUBICODE	Rationalising Biodiversity Conservation in Dynamic Ecosystems http://www.rubicode.net/rubicode/index.html See Part 1 Section 3.2
SHARE	Sustainable Hydropower in Alpine Rivers Ecosystems http://www.share-alpinerivers.eu/ See Part 1 Section 2.1 and Part 2 Section 5.3
TEEB	The Economics of Ecosystems and Biodiversity http://www.teebweb.org/ See Part 1 Section 1
TRUST	Tools for Regional Scale assessment of groUndwater storage improvement in adaptation to climate change http://www.lifetrust.it/cms/ See Part 1 Section 2.1 and Part 2 Section 5.1
Upstream Thinking	Improving raw water quality in West Country Rivers, UK http://www.wrt.org.uk/projects/upstreamthinking/upstreamthinking.html See Part 2 Section 5.2
Waternet	Payment for Ecosystem Services scheme in the Netherlands www.watermaatwerk.nl See Part 2 Section 5.2

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The Indicators Ad Hoc Technical Expert Group (AHTEG), Subsidiary Body on Scientific, Technical and Technological Advice (SBSTTA)
http://www.cbd.int/doc/?meeting=sbstta-15

Ecosystem Services Partnership focuses on researching on the dynamics and Valuation of Ecosystem Services and Natural Capital (develop quantification methods, models and data bases)
http://www.es-partnership.org

Integrated Valuation of Ecosystem Services and Tradeoffs (InVEST), freely available software tool developed by the Natural Capital Project (Stanford University, The Nature Conservancy and World Wildlife Fund)
http://www.naturalcapitalproject.org/InVEST.html

Millenium Ecosystem Assesssment
http://www.maweb.org

Sixth World Water Forum, 12 – 17 March 2012, Marseille, France
http://www.worldwaterforum6.org/commissions/thematic/priorities-foraction-and-conditions-for-success/

The Economics of Ecosystems and Biodiversity (TEEB)
TEEB for Policy Makers Report
http://www.teebweb.org/ForPolicymakers/tabid/1019/language/en-US/Default.aspx
TEEB for Local and Regional Policy Makers Report
http://www.teebweb.org/ForLocalandRegionalPolicy/LocalandRegionalPolicyMakersChapterDrafts/tabid/29433/Default.aspx

Valuing Nature Network
www.valuing-nature.net

Water Footprint Network
http://www.waterfootprint.org

European organisations and initiatives

BISE — Information platform, Biodiversity information System for Europe to facilitate the planning and development of ecosystem assessments in Europe and includes a repository of ESA case studies
http://biodiversity.europa.eu/ecosystem-assessments

European Union
EU SEA Directive 2001
http://ec.europa.eu/environment/eia/sea-legalcontext.htm

EU biodiversity strategy 2011
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http://ec.europa.eu/environment/water/blueprint/index_en.htm

IWRM-Net Scientific Coordination Project
(Integrated Water Resource management Network)
http://www.iwrm-net.eu/
IWRM-Net ESAWADI Project
http://www.esawadi.eu/
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http://forecaster.deltares.nl/index.php?title=Forecaster
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www.psiconnect.eu

Research project in Denmark (methods to evaluate soft ecosystem services
in two urban fringe areas in Copenhagen)
http://ec.europa.eu/environment/integration/research/newsalert/pdf/194na4.pdf

WATECO (WATer ECOnomics), working group of the WFD CIS
http://www.waterframeworkdirective.wdd.moa.gov.cy/docs/
GuidanceDocuments/Guidancedoc1WATECO.pdf

National organisations and initiatives

BELGIUM

Natuurwaardeverkenner, Manual and web-based tool to support the
valuation of ecosystem services in Flanders, Belgium
http://rma.vito.be/natuurwaardeverkenner/

FRANCE

Agence de l'Eau Rhône Mediterranée & Corse
http://www.rhone-mediterranee.eaufrance.fr/docs/dce/sdage/docscomplementaires/
BonEtatEaux_mars2011.pdf

French Ministry of Ecology website
http://www.developpement-durable.gouv.fr/

Gaié, Groupe d'Application de l'Ingénierie des Ecosystèmes
http://www.ingenierie-ecologique.org/spip.php?article27

Onema (French National Agency for Water and Aquatic Environments)
http://www.onema.fr/IMG/EV/cat7a-ecological-services.html

GERMANY

"Cultural ecosystem services and quality of life" project, Berlin
Brandenburgische Science Academy
http://www.ecosystemservices.de/subprojects/subproject-3.1200 201

German federal government
Economic valuation of dike relocation in the German Elbe, Volkmar Hartje,

Institut für Landschaftsarchitektur und Umweltplanung
http://www.landschaftsoekonomie.tu-berlin.de/menue/research/projects/oekonomische_bewertung_naturvertraeglicher_hochwasservorsorge_an_der_elbe/parameter/en/

MONERIS Model, IGB-Berlin
http://moneris.igb-berlin.de/index.php/model-structure.html
Nature Valuation and Financing Network website
www.naturevaluation.org

IRELAND

Irish EPA, a desk study project to systematically evaluate the policy and environmental context important for the protection of high status sites
http://www.inarchive.com/page/2011-12-17/http://www.highstatusireland.ie/

ITALY

TRUST Project (Tool for Regional scale assessment of groUndwater STorage improvement in adaptation to climate change), funded by the 2007 LIFE Plus Environment Policy and Governance Program of the EC and by the Italian Ministry of Environment, Land and Sea.
http://www.lifetrust.it/cms/

NETHERLANDS

Nature Value Indicator (NVI) from the Netherlands Environmental Assessment Agency
http://www.pbl.nl/en

UNITED-KINGDOM

UK National Ecosystem Assessment (UK NEA)
http://uknea.unep-wcmc.org/Resources/tabid/82/Default.aspx

UK - Valuation
NERC Valuing Nature Network
- Valuing the impacts of ecosystem service interactions for policy effectiveness
http://www.valuing-nature.net/projects/agricultural-management
- Interdisciplinary quantitative ecosystem services team (INQUEST)
http://www.valuing-nature.net/projects/uncertainty-scale

The Mayes Brook restoration and associated Mayesbrook Park regeneration project in urban east London used the ES approach
http://www.naturalengland.org.uk/regions/london/ourwork/integratedprojects.aspx

UNITED STATES

New York City Watershed Agricultural Council
http://www.nycwatershed.org/

"2nd Water Science meets Policy" Event

"Implementation of the WFD: when ecosystem services come into play"

Agenda

Day 1 - 29 September 2011

13:00 Welcome Address **(Amphitheatre Albert II)**

Manuela Soares, DG RTD

Patrick Lavarde, ONEMA

Session 1: (PLENARY) The use of ecosystem services for the implementation of the WFD: possible methods, inspiring examples and challenges

General Introduction

13:20 Ecosystems services and water management
- A scientist's point of view (Jean-Pierre Amigues, INRA, FR)
- A manager's point of view (Mark Everard, EADW, UK)

13:50 Mapping and valuation of water purification services in Europe (Joachim Maes, JRC, EC)

Possible valuation methods for ecosystem services and WFD

14:10 Economic Analysis for Ecosystem Service Assessments (Ian Bateman, CSERGE, UK)

14:30 Incentive mechanisms for the payment of ecosystem service: is Full-Cost Recovery the right one? (Antonio Massarutto, University of Udine, IT)

14:50 What to do when valuation of ecosystem services fails? (Frank Dietz, PBL Netherlands Environmental Assessment Agency, NL)

15:10 Coffee Break **(Throne Room)**

How can this approach be connected and used to reach WFD objectives?

15:40 Utilizing the ESA for WFD implementation between theory and practice: opportunities and challenges (Eduard Interwies, InterSus, DE)

16:00 Strategy regarding the ecosystem services approach in the frame of 2nd River Basin Management Plan (RBMP) in Romania (Christian Rusu, Apele Romane, RO)

16:20 Management Strategies for the protection of High-Status water bodies (Bernadette Ni Chathain, RPS, IE)

16:40 Panel discussion

17:30 END DAY 1

19:30 Social event - at the Royal Flemish Academy of Belgium for science and Art **(Marble Room)**

The event is kindly hosted by the Royal Flemish Academy for Sciences and the Arts

Event programme

Day 2 - 30 September 2011

08:30 Welcome Coffee

SESSION 2: FUTURE PERSPECTIVES **(THRONE ROOM)**

09:00 Perspectives for the strategic plan for Biodiversity 2011-2020 (James Williams, JNCC, UK)

09:20 Perspectives for the 2012 Blueprint to safeguard water resources (Jacques Delsalle, DG Environment, EC)

SESSION 3: ROUNDTABLES BASED ON KEY ISSUES RELATED TO 3 CHOSEN SUBJECTS

09:40 Introduction to the roundtables [PLENARY]

09:45 Parallel roundtable discussions

Round table	Quantity Management: water scarcity and flood protection	Water quality and diffuse pollution	Hydromorphology: maintaining and restoring good status	Role playing in the use of Ecosystem Services for WFD
ROOM	Throne	Beaudoin	Ockegehen	Library
Chairperson	Maggie Kossida	Ville Keskisarja & Bob Harris,	Marina Bussettini	FP7 PSI-Connect project
Rapporteur	Eduard Interwies	Jos Brils	Tom Buijse	
Presenter 1	Volkmar Hartje, Elbe River	Angiolo Martinelli Lake Trasimeno	Philippe Blanchar Dordogne River	
Presenter 2	Francesco Baruffi, Veneto-Friuli water system	Nicolaas van Everdingen, Amsterdam Watershed	Andrea Mammoliti Mochet, Alpine river ecosystems	
Presenter 3		Dylan Bright, Tamar River		

Proposed round table process;

1 Introduction: Presentation of WFD objectives in relation to the round table theme **by chairperson**, notes taken by **rapporteur**

2 Case study presentations

3 Analysis: plenary session moderated by **chairperson**

4 Wrap-up by **chairperson**

12:45 Lunch **(Atrium)**

SESSION 4: (PLENARY) INTEGRATION AND CONCLUSIONS **(THRONE ROOM)**

14:00 Presentation - 6th World Water Forum - Explanation of *European Regional Process and enabling environments (11 Promote technology innovation, Science-Policy interface and dialogue ...)*

14:15 Restitution of each roundtable

15:15 Discussion and questions

15:45 CONCLUDING REMARKS (ONEMA, DG RTD)

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Full PowerPoint presentations are available for download on the CIRCA public library website *(http://circa.europa.eu/Public/irc/env/wfd/library?l=/framework_directive/implementation_conventio/interface_september_1&vm=detailed&sb=Title)*

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This document is part of the "Meeting Recap" collection, intended for technicians and interested persons. It presents the main elements of meetings co-organised by Onema and DG R&I.

Already published
Climate change. Impacts on aquatic environments and consequences for management (December 2011)
Mesocosms. Their value as tools for managing the quality of aquatic environments (December 2011)
Economic instruments to support water policy in Europe: paving the way for research and future development (December 2011)
Drinking-water abstractions and nonpoint-source pollution: operational solutions for supply zones of priority water abstractions (December 2011)

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