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Getting into the water with the Ecosystem Services Approach: The DESSIN ESS evaluation framework

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ABSTRACT

Driven by Europe's pressing need to overcome its water quality and water scarcity challenges, the speed of innovation in the water sector is outpacing that of science. The methodologies available to assess the impact of innovative solutions to water-related challenges remain limited and highly theoretical, which sets boundaries on their application and usefulness to water practitioners. This hampers the uptake of new technologies and innovative management practices, thus foregoing potential gains in resource efficiency and nature protection, as well as wider benefits to society and the economy. To address this gap, the DESSIN project developed a framework to evaluate the changes in ecosystem services (ESS) associated with technical or management solutions implemented at the water body, sub-catchment or catchment level. The framework was developed with a specific focus on freshwater ecosystems to allow for a more detailed exploration of practical implementation issues. Its development, testing and validation was carried out by conducting ESS evaluations in three different urban case study settings. The framework builds upon existing classification systems for ESS (CICES and FEGS-CS) and incorporates the DPSIR adaptive management scheme as its main structural element. This enables compatibility with other international initiatives on ESS assessments and establishes a direct link to the EU Water Framework Directive, respectively. This work furthers research on practical implementation of the Ecosystem Services Approach, while pushing the discussion on how to promote more informed decision-making and support innovation uptake to address Europe's current water-related challenges.

1. Introduction

Europe currently faces great challenges regarding water quality and water scarcity, which coincide with growing economic uncertainty in the region (e.g., political changes, financial fluxes, labour market shifts, among other factors). These challenges can become especially adverse in urban areas, where they can be compounded by increasing population levels and overburdened water and wastewater infrastructures (Koop and van Leeuwen, 2017). Consequently, the EU has opted to direct part of its research, development and innovation efforts in the water sector towards increasing the knowledge base on aquatic ecosystems and water management (often with special focus on urban areas, e.g. EEA,

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2016; Dige et al., 2017) and promoting the uptake and commercialisation of innovative solutions for water supply and treatment (Aho et al., 2014; Schmidt et al., 2016). Examples of such innovative solutions may include new techniques to replenish groundwater resources or treat combined sewage in a decentralised way.

Oftentimes, as new technologies and management approaches emerge, the limitations of the available impact assessment methodologies become evident. Enhancements in such assessment approaches are thus necessary to ensure that the full range of possible impacts on natural systems is accounted for. These enhancements may refer, for instance, to new ways of measuring the benefits that humans perceive from their interaction with nature. In this context, European policy has placed increased interest in the concept of Ecosystem Services (ESS) and the Ecosystem Services Approach (ESA) (Bouwma et al., 2017). In particular, these are perceived to have great potential for enabling more holistic evaluations of the impacts resulting from new interventions. These evaluations should, in particular, integrate economic, environmental and societal dimensions.

To date, much research has been conducted on the concept of ESS and the multiple aspects concerning its potential as a support tool for policy- and decision-making, e.g. the Millennium Assessment (MA, 2003; 2005), The Economics of Ecosystems and Biodiversity (TEEB, 2008; 2010), initiatives in this field through the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES, 2014; Díaz et al., 2015) and the EU-Working Group MAES (Maes et al., 2013, 2016), as well as research projects such as GLOBAQUA (Navarro-Ortega et al., 2015), AQUACROSS (Gómez et al., 2016), MARS (Hering et al., 2015), OpenNESS (Potschin et al., 2014), OPERAS (Kettunen and Brink 2015) and POLICYMIX (Barton et al., 2014). However, and despite the progress achieved so far, the practical application of the ESA continues to be hindered by its highly theoretical nature and by the fact that those involved in such applications are required to transgress disciplinary boundaries if they want to exploit the approach to its fullest extent. This can result in difficulties - the causes for which range from inconsistencies in the use of terminology to contradictory handling of fundamental ESS concepts. In addition, the most advanced efforts are those that focus on national ESS assessments, where downscaling issues have been pointed out by critics as a strong limitation (Potschin and Haines-Young, 2013; Paetzold et al., 2010; Costanza et al., 2014).

In response to these issues, the FP7 project DESSIN (Demonstrate Ecosystem Services Enabling Innovation in the Water Sector), funded by the European Commission, set out to demonstrate innovative solutions to water-related challenges and to develop an evaluation framework to measure their impacts on ESS. In this sense, DESSIN endeavours to contribute to the discussion by bringing forward an evaluation framework that is a) focused on changes resulting from concrete measures implemented at the local level and b) applicable to produce output that can be extrapolated from the bottom-up. The project's exclusive focus on freshwater ecosystems and their services allows for a more concentrated discussion and development work that in turn enables a more detailed exploration of practical implementation issues.

This paper aims to introduce the DESSIN ESS Evaluation Framework to the wider scientific community and to promote its use and further development as a tool for conducting local-level applications of the ESA. The following sections provide an overview of the justification and objective of the framework (Section 2), the rationale for its development based on practical case studies (Section 3), and its conceptual approach (Section 4) and design (Section 5). Sections 6 and 7 then present a discussion of the aforementioned aspects and general conclusions, respectively.

2. Justification and objective

Decision-making in water management relies on information describing ecological, economic, and social aspects collated in a transparent way. Handling, integrating and interpreting such information requires a balanced combination of administrative capacity and specialized expertise. This means water managers and similar authorities in charge of freshwater ecosystems have to collaborate with natural scientists, social scientists, engineers, economists and others in order to reach sound decisions. Tools that support this collaboration, especially through facilitating communication across disciplines, are thus required. A literature review revealed multiple existing ESS assessment frameworks that lay out methodologies linking ESS to human well-being, and that could be useful for authorities and organisations involved in water management (MA, 2003, 2005; TEEB, 2008, 2010; Harrison, 2010; Paetzold et al., 2010; Keeler et al., 2012; Peh et al., 2013; Seppelt et al., 2012). However, some of these frameworks cannot identify how changes in ecosystems impact the provision of ESS, while others are overly time and/or data intensive, focus solely or mainly on a single water issue (e.g., water quality or water scarcity), are limited in their coverage of ESS types (e.g. focus on provisioning services), or exclude sustainability considerations. Furthermore, no direct link between such ESS assessment frameworks and the Water Framework Directive (WFD) seems evident, at a time when integration between WFD objectives and ESS principles is being pursued (Vlachopoulou et al., 2014).

The DESSIN framework aims to enable the practical application of the ESA at the level of an environmental system of interest (e.g. a surface or groundwater body, sub-catchment or catchment) to assist decision-making that considers the specific and current strains put on the ecosystem in focus and the direct effects of a technical or management solution upon it. As opposed to other established assessments that produce aggregate accounts of the services provided by a region's or nation's ecosystems (INBO, 2014; Marta-Pedroso et al., 2014; The Finnish Environment, 2015), the DESSIN framework allows its users to evaluate changes in ESS related to the measures implemented in a given freshwater ecosystem. In other words, the framework focuses on local-level assessments to allow its user to associate small-scale interventions to potential impacts on environmental, economic and social domains. Where quantification of ESS is not possible due to a lack of information, the framework allows for the formulation of qualitative arguments that can also be helpful for consultation and decision-making. The framework facilitates scenario analysis and the comparison amongst different solutions. Furthermore, it includes the option to take broader-term aspects of sustainability of the specific measure into account (detailed descriptions follow in Section 5.2).

The framework builds upon an existing classification system for ESS and a well-established methodological scheme that are generally known and accepted in European ESS research circles. These are the Common International Classification of Ecosystem Services (CICES) developed by Haines-Young and Potschin (2011) and the Driver, Pressure, State, Impact, Response (DPSIR) adaptive management scheme created by the European Environment Agency (1999). In addition, the framework incorporates some of the notions and elements behind the Final Ecosystem Goods and Services-Classification System (FEGS-CS) elaborated by Landers and Nahlik (2013), and the sustainability assessment tool developed in the TRUST project (Alegre et al., 2012).

Adopting the CICES typology ensures that evaluations conducted using the DESSIN framework are compatible and comparable with other assessments undertaken by European institutions. Using the DPSIR scheme as the main structural element of the