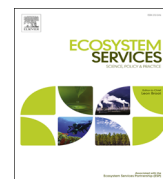




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A methodology for the assessment of local-scale changes in marine environmental benefits and its application

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ABSTRACT

Local-scale planning decisions are required by the existing Environmental Impact Assessment process to take account of the implications of a development on a range of environmental and social factors, and could therefore be supported by an ecosystem services approach. However, empirical assessments at a local scale within the marine environment have focused on only a single or limited set of services. This paper tests the applicability of the ecosystem services approach to environmental impact appraisal by considering how the identification and quantification of a comprehensive suite of benefits provided at a local scale might proceed in practice. A methodology for conducting an Environmental Benefits Assessment (EBA) is proposed, the underlying framework for which follows the recent literature by placing the emphasis on ecosystem benefits, as opposed to services. The EBA methodology also proposes metrics that can be quantified at local scale, and is tested using a case study of a hypothetical tidal barrage development in the Taw Torridge estuary in North Devon, UK. By suggesting some practical steps for assessing environmental benefits, this study aims to stimulate discussion and so advance the development of methods for implementing ecosystem service approaches at a local scale.

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1. Introduction: the evolution of ecosystem service frameworks

Ecosystem services approaches have developed with the aim of providing a common language and a transparent framework for quantifying the ecological, social and economic trade-offs that must be evaluated in development decisions (Granek et al., 2010). The Millennium Ecosystem Assessment (MEA, 2003) proposed a classification of provisioning, regulating, cultural and supporting services. Subsequent frameworks have sought to more clearly distinguish between services and benefits on the basis that evaluating benefits avoids double counting (Fisher et al., 2009). Thus, The Economics of Ecosystems and Biodiversity (TEEB, 2010) and the UK National Ecosystem Assessment (2011) have both developed typologies that attempt to distinguish between services providing direct and indirect benefits. Other authors have sought to expand classification frameworks so that, as well as ecological parameters, they include benefits derived solely from the abiotic elements of the environment such as the use of space for transportation (Balmford et al., 2008; Saunders et al., 2010). Further refinements to ecosystem service classifications have been suggested under the Common International Classification of

Ecosystem Services (Haines-Young and Potschin, 2013), whilst the inclusion of cultural services has been the topic of a recent debate in the literature (Daniel et al., 2012; Kirchoff, 2012; Chan et al., 2012).

The operational usefulness of conceptual frameworks can only be determined by applying them in the field. Conceptual frameworks include a broad suite of ecosystem services, but empirical research tends to focus on services individually or on a limited set (Rees et al., 2012; Mangi et al., 2011; Luisetti et al., 2011; Pittock et al., 2012; Balvanera et al., 2006). Further studies that attempt simultaneous assessment of a large suite of ecosystem services are required as lessons learned from such empirical application will help to aid development of the ecosystem services approach as a practical tool for supporting decision making in natural resource management.

In this paper we propose a framework methodology that supports application of the ecosystem services concept to local environmental impact appraisal, and then explore implementation of the methodology through a case study of a hypothetical tidal barrage in an estuary in south west England.

2. Developing a tool for local environmental impact appraisal

The context of this research is to evaluate the potential for ecosystem service assessments to support decision-making with

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respect to a specific local-level intervention. Across Europe, appraisal of the environmental impact of a development is currently governed by the Strategic Environmental Assessment (SEA) Directive (Directive 2001/42/EC) and the Environmental Impact Assessment (EIA) Directive (Directive 2011/92/EU), for, respectively, public programmes and individual projects. Both are procedures that seek to ensure that environmental implications are appropriately considered in decision-making and similar policy and legal tools are used internationally.

The SEA and EIA Directives are conceptually well aligned with the ecosystem services approach since they both consider the environment as more than its ecological parameters, and contain explicit reference to the need for evaluations to consider people, material assets and cultural heritage. The procedures they prescribe for the appraisal of environmental impacts already include assessment of the effects of developments on a wide range of environmental, social and economic benefits. However, in categorising the parameters to be assessed, the approach taken in the SEA and EIA guidance has not been systematic. To use tidal barrages as an example (as the subject of the case study presented in Section 4 below), a SEA was carried out as part of a recent feasibility study on a potential Severn Barrage (Parsons Brinckerhoff, 2010), and further guidance for compiling EIAs for tidal barrages has also been produced (Environment Agency, 2002). The categorisation used within both the SEA and EIA guidance causes duplication, with, for example, noise, flood risk and water quality listed as significant issues in more than one SEA topic, and visual amenity appearing in two EIA categories.

Also, the SEA approach as applied to the Severn Estuary does not lead easily to the step of valuation, which can facilitate decision-making by quantifying the impacts using a common metric, thus supporting cost-benefit analysis. This is because no distinction is made in presenting information on ecosystem processes (such as saltmarsh functionality), services (including water quality) and environmental benefits (for example availability of commercial fish species), and so it is not immediately apparent for which of the parameters detailed valuation should be attempted. Therefore, there remains scope to develop a methodology that ensures a systematic and comprehensive treatment of the full range of benefits likely to be affected, and facilitates an additional step of valuing these benefits to allow their quantification in a common metric. The Environmental Benefits Assessment methodology proposed below aims to address these issues in relation to specific local-level interventions.

3. Proposed methodology for an environmental benefit assessment (EBA)

The first stage of an environmental benefit assessment (EBA) is to characterise the site and identify stakeholders as this is fundamental to gaining an understanding of the benefits delivered prior to the proposed development. The current situation is then described through (i) compiling an inventory of the environmental benefits obtained from the site; (ii) quantifying the current level of delivery of each benefits; and (iii) determining their relative importance. The change in the level of delivery of the environmental benefits as a result of proposed development is then examined. These steps are described in more detail below.

3.1. Definitions

The proposed methodology follows Balmford et al. (2008) and Saunders et al. (2010) by including services provided solely by the abiotic elements of the environment as well as those with an

ecological basis. This ensures that the assessment can accommodate all the potential implications of a proposed infrastructure development within a single process and is in line with the SEA/EIA process, which considers benefits such as transport. The term 'environmental services' is used to describe this extended classification, and is defined as the conditions and processes through which natural ecosystems, and the species and abiotic characteristics that make them up, sustain and fulfil human life (adapted from Daily, 1997).

The methodology seeks to identify and quantify benefits (as opposed to the services that provide them), because it aims to facilitate ecosystem valuation. Operationally, ecosystem valuation is much simplified by considering only the ecosystem endpoint that yields a valuable benefit and not the complex processes by which it was provided, as measurement of the latter is much more complex (Boyd and Banzhaf, 2007). Definitions that clearly distinguish between services and benefits are essential (Fisher et al., 2009), and it has been suggested that the separate term 'ecosystem benefit' could be explicitly defined and applied within valuation frameworks to reflect this (Wallace, 2007; Fisher and Turner, 2008). The proposed methodology will therefore also use the term 'environmental benefit', which is defined as the point at which a direct gain in human welfare provided by environmental services is realised (adapted from Fisher et al., 2009). Environmental benefits can be considered synonymous with 'goods' as defined in the UK National Ecosystem Assessment (2011), but is more easily interpreted as an overarching classification that includes benefits beyond the generation of tangible objects.

3.2. Site characterisation and identification of stakeholders

The concept of environmental benefits is anthropocentric. At the outset of any assessment it is important to understand the social, economic and cultural issues within the local area where an assessment is required, as these are integral to the realisation and perception of environmental benefits. Such understanding is gained by collating information on the socio-demographic characteristics of the local population, land use, economic activity and employment, as well as the environmental characteristics of the area (including existing environmental protection measures). Understanding the character and use of the area helps to identify stakeholders (organisations and individuals) from whom specific information can be sought. These stakeholders may not all be local; it is likely that there will often be regional, national and potentially international interest in the area.

3.3. Identifying relevant environmental benefits

A comprehensive inventory of the environmental benefits provided by the site is required at the start of any assessment, so that the full scope of potential impacts can be understood. The environmental benefits provided may be realised or transferred elsewhere (for example, carbon sequestration and the health benefits of recreation), but the EBA is concerned with the implications of a development on the supply of all benefits from the local site. Local and wider knowledge is essential in compiling an environmental benefits inventory for a particular site, requiring consultations with local stakeholders and examination of any relevant grey literature.

The creation of an inventory is facilitated by a classification framework providing a coherent categorisation of environmental benefits. In this methodology, a classification framework was developed that draws heavily on the existing literature, but aims to facilitate operational assessment in a specific context rather than provide examples to illustrate a concept. The foundation of the framework was the definition of the types of values

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