Bringing Ecosystem Services into Environmental Management, Especially at the Landscape Scale

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Abstract

This paper reviews main ideas and literature concerning ecosystem services, to introduce the field to IA practitioners. Ecosystem services can contribute to environmental management, more broadly, and are beginning to be used with impact assessment. We describe several major approaches that use ecosystem services and a scoping process that introduced ecosystem services into the professional practice of two local partners.

Introduction

Ecosystem services (ES) is a rapidly evolving field. Its early applications have been largely at national and regional scales and its ideas are not yet well integrated into the literature of impact assessment. The purpose of this paper is to help practitioners get started with ES by 1) introducing major ideas associated with ecosystem services, 2) indicating how they can be used in environmental management and impact assessment in more local landscape scale projects, and 3) introducing key literature.

What are Ecosystem Services and Natural Capital

"Ecosystem services can be broadly defined as the aspects of ecosystems that provide benefits to people." (Turner et al. 2008)

"Natural capital is the land, air, water, living organisms and all formations of the Earth's biosphere that provide us with ecosystem goods and services." (IISD 2008) [note that 'ecosystem services' is equivalent to 'ecosystem goods and services']

The definitions above reveal two essential ideas about ecosystem services, represented in Figure 1. First, there are three major features to be considered: the components of natural ecosystems, the services they provide, and the benefits that people get from those services. The second is that ecosystems and biodiversity on the landscape provide a physical 'stock' of resources (natural capital) that provides a continuing 'flow' of services and benefits to people.

Ecosystems (or 'natural capital') → ecosystem services → benefits to people

Figure 1 A cascade of influence from nature to human well-being

The idea behind emphasizing ecosystem services (Daily 1997) was that society would better protect both people and nature if decision makers knew that:

- there are more ecosystem services,
- which provide far more benefits, than most people realize, and
- those benefits have a monetary worth which is often very high.

Ultimately, the central message is that preserving the flow of services and benefits to people requires greater efforts to preserve and restore natural ecosystems.

Major Approaches for Working with Ecosystem Services

Two major ways can be described in which ecosystem services are used as the central tool for planning and management: ecosystem assessments and mapping and modeling methods.

The *Millennium Ecosystem Assessment* (MA) published in 2005 by the United Nations (MA 2005) was a major milestone. It used ecosystem services to measure the state of the planet's resources. The project popularized the concept of ecosystem services and is still the source for many ES ideas. The MA used a broad approach to 'ecosystem assessment' that identified ecosystem services, their beneficiaries, the direct and indirect drivers of change in ES (mostly human actions), assigned values to the services (often economic ones), and considered scenarios of alternative futures in the light of different chosen actions (MA 2005, Ash et al. 2010).

The Economics of Ecosystems and Biodiversity (TEEB) project expanded upon the MA ecosystem assessment approach (Kumar 2010). It had more emphasis on detailed economic analysis and policy linkages. It included guidelines that apply at a local scale (TEEB 2010, TEEB 2011). Recently, the United Kingdom's *National Ecosystem Assessment* (UK NEA 2011) and the *Common International Classification of Ecosystem Services* project (Haines-Young and Potschin 2013) show further advances using ecosystem services within ecosystem assessments.

A different approach to planning with ecosystem services uses models and maps of 'ecological production functions.' It is best known from the InVEST computer models of the *Natural Capital Project* (Karieva et al. 2011). The approach uses mathematical models for features of the landscape and calculates the ecosystem services they produce (e.g., biodiversity protection, carbon sequestration), how they are used and their economic worth. The models generate maps and planning scenarios to aid decision making. Other efforts also emphasize mapping natural features and ecosystem services, evaluating worth and planning but do not use detailed simulation models (Chan et al. 2006, Fisher et al. 2011, Qui and Turner 2013).

The ecosystem assessment and mapping approaches just described use natural capital, ecosystem services and human benefits as their central focus. They produce much information and could substantially contribute to social planning and decision making. However, they require a large amount of data, are often time-consuming and expensive, and are typically regional in geographical scope rather than project focused.

Practitioners unfamiliar with ecosystem services might find the comprehensive ES-focused approaches just described to be inappropriate for their purposes. Instead, they might want to start using the idea of ES in a simpler way, as one new element to enhance environmental management practices they are already familiar with. They might want smaller, more local or more project focused approaches, that can use ecosystem services ideas.

The next three sections describe ways in which ES can be incorporated into, and complement, environmental planning and management practices, especially at more local geographical scales.

Planning with Valuation Studies and Payments for Ecosystem Services

The approaches described above all involve sequential steps. One of those steps, and the one that attracts more published literature than any other, is that of economic valuation.

Some of nature's goods (e.g., crops, harvested fish) have prices in markets but many, like water, usually do not have a price. Many services that 'regulate' natural events (like flood control), and cultural benefits, like aesthetic appreciation and recreation, usually do not have prices. Economists have developed many economic techniques to estimate monetary values of ecosystem services without using prices from markets (DEFRA 2007, EPA 2007, TEEB 2010). Such economic valuation studies can be used on their own, as an environmental management tool. For example, economic values of the ecosystem services of specific landscapes can be calculated (e.g., Wilson 2010). Such measurements can be used for planning activities. Another economic analysis is possible where nature offers 'green infrastructure' (e.g., a watershed which filters water) which can be explicitly compared to built or 'grey' infrastructure (e.g., a potential water filtration plant) (CNT 2010). If the green infrastructure is cheaper, using it can become a policy recommendation. (There are also methods to include non-monetary values (Martin-Lopez et al. 2013)).

One way to keep forests intact, so they will continue to filter water and reduce floods for a downstream city, is to pay the owner to keep them intact rather than cutting them down. Payments for Ecosystem Services (PES) programs are built upon that approach. PES efforts are quite well established for watershed services, carbon sequestration, biodiversity and visual amenities (Katoomba Group 2008).

Local Landscape Management for Multifunctional Landscapes and Ecological Restoration

Two environmental fields provide established practices which professionals can draw upon to manage and protect ecosystem services.

The 'multifunctional landscape' approach has as its goal mixed use of urban and rural landscapes while retaining the benefits of forests, streams and other landscape features (O'Farrell and Anderson 2010). This approach has begun to explicitly include ecosystem services in its methods. A program called SITES (2009) provides guidelines and checklists that show how good practices, including materials chosen and planning for water and vegetation during nine phases of landscape development, can protect ecosystem services at the regional, local and individual building-site scales.

Ecological restoration is concerned with assisting the rehabilitation of degraded land (Greipsson, 2011). The idea of 'restoring natural capital' (Aronson et al. 2007) gives additional conceptual and economic support for restoration practices and links the field with ecosystem services.

Ecosystem Services and Connections to Impact Assessment

The Millennium Ecosystem Assessment has 'assessment' in its title. But descriptions of the MA projects (MA 2005) and subsequent how-to documents (Ragnanathan et al. 2008, Ash et al. 2010) provide little reference to IA literature. More recently, the TEEB report for local and regional policy makers explicitly includes Strategic Environmental Assessment (SEA) and project IA as policy tools that can use ES (TEEB 2010). The World Resources Institute (WRI) offers a process to link ecosystem services and the MA framework to project IA (Landsberg et al. 2011). The TEEB and WRI methods start with an ecosystem services framework and lead to IA. Many practitioners might prefer to start with the IA processes they are familiar with, and add elements of ES to them.

ES is being integrated with IA. A special issue of the journal *Environmental Impact Assessment Review* in April 2013 was devoted to Ecosystem Services. Specific applications are now discussed, such as ES and SEA (Geneletti 2011) and a checklist for considering ES in IA for the oil and gas industry (IPIECA 2011).

Two distinct options start with existing impact assessment processes and add consideration of ecosystem services. First, project-specific IA usually identifies specific biophysical or social features in the scoping phase. Such valued components (VCs) are established as targets for further study. Identifying one or more elements of the natural capital—ecosystem service—human benefits cascade among a project's VCs seems a likely step. ES are explicitly related to human uses, so attention to the ES cascade brings socio-economic matters into IA, which is often recommended. Second, remember that regional and national approaches are the focus for many large scale ES projects. Ecosystem assessments, or ecological production function modeling, could be linked to regionally-focused cumulative impact assessment or strategic environmental assessment.

Example at a Local Landscape Scale

We tested steps to introduce ecosystem services in local environmental management. We worked with a suburban city and with a watershed management NGO in British Columbia. They started with no required legislation and no specific projects they had to address. Rather, they wanted to pro-actively add ecosystem services to their professional repertoire, but were not sure how. We built upon general ES approaches and added an IA flavor. We expanded and modified the second step of the TEEB (2011) process (identify ecosystem services), and used it for scoping.

In participatory workshops, we first discussed and identified which ecosystem services in the TEEB categories were present in their local landscapes. Using tables and matrices we linked different services with their benefits and potential beneficiaries at local, regional and national scales, and then ranked their relative importance. These steps gave our partners a new perspective on what ES were in their area and how they connected to projects and stakeholders. Then they made choices about how to link further ES work with concerns relevant for them.

Our municipal partner identified many locally important services associated with a wetland already known to be environmentally significant. They are exploring its ecosystem services in more detail, to demonstrate additional reasons to justify existing conservation practices, and as a case study to show the usefulness of ES to their city. The NGO choose to look further at the ecosystem services

that benefited one important local group they wanted to work with—agricultural producers. They are focusing on the ways to show the benefits of protecting and restoring vegetated stream corridors and native pollinators. Both partners are trying to link ES with policy tools, as described in TEEB (2010). So, a scoping process that explored ecosystem services generated useful management ideas for using ES at the local landscape scale.

Conclusions

The use of ecosystem services in environmental management is expanding rapidly. Techniques for large ecosystem assessments have evolved, with the TEEB process and UK NEA setting new standards. Customized use of ES-related tools, such as valuations and payments for services, and linkages to local policy are increasing. Existing environmental management practices are embracing ecosystem services at a local landscape scale. Increased adoption of a multifunctional landscape perspective, use of SITES guidelines, expanding attention to restoring natural capital, and adopting ecosystem services within IA practice, seem likely applications for ecosystem services in the near future.

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