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Ecosystem services in practice: Challenges to real world implementation of ecosystem services across multiple landscapes – A critical review

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ABSTRACT

Ecosystem services (ES) and ecosystem services assessment (ESA) have become common parlance in the environmental field. Scientists, policy-makers and activists have promoted the ES approach as a means of conveying the extent of threats to natural ecosystems with the goal of crafting socially acceptable and effective policy to address ecological threats and biodiversity conservation. Yet there are some significant challenges to wide acceptance of the ES approach which hinder its absorption into the mainstream geography literature. This paper reviews the historical development of the ES approach focusing on its relevance to applied geography at different stages of its development, describes the present state-of-the-art of ES, and synthesizes the results from several seminal papers and reports. I posit that there are two major stumbling blocks: 1) the difficulty of simplifying complexities between services so that statutory planning processes can incorporate the approach, and 2) the lack of cross-landscape assessment methods and examples. If we focus on the most immediately surmountable challenges to the ES approach much progress could be made in a short time. The subsequent and final substantive section of this review summaries these challenges and offers some suggestions for moving forward.

Introduction

Ecosystem services (ES) and ecosystem services assessment (ESA) have become common parlance in the environmental field. ESA which provides a way to anticipate the effects of impending changes, has become one of the most prominent frameworks for spatial planning and land use management. The connection of the approach to geography has to do, first and foremost, with the influences of location on the characteristics of services. Yet despite growing attention to ES in geography literature much of it has failed to achieve broad, general appeal.

Among the reasons why the field of geography should concern itself with ES and ESA is because almost all ESAs are dependent on the mapping of ES and on the use of geographic information system (GIS) tools. Further, the evolution of ESA has engendered the broadening of the definition of ES and tools for ESA to account for as many services as possible. It is hoped that this will facilitate reaching the full potential of the approach for conservation as intended by environmental professionals. As such, the ES approach has come to depend on the many sub-fields of geography, including socio-cultural geography, economic geography and biogeography. Even historical geography has relevance for ES; historical environmental conditions can determine current or future services. For example, identification of historical extents of species' dispersal and species' natural habitats aid in assessing present and future additions or losses to ES (Moilanen et al., 2005).

Scientists, policy-makers and activists have promoted the ES approach as a means of conveying the extent of threats to natural ecosystems with the goal of crafting socially acceptable and effective policy to address ecological threats. Environmental geography should recognize and integrate between the fields of spatial ecology and geography to support the practical application of ES as a "language" for environmental protection. According to some environmentalists, ES is the last great hope for making biodiversity and environmental conservation a priority for planning and resource management.

This article looks critically at some of current challenges to the ES approach, challenges that are that are obstacles to its absorption in the mainstream geography literature. Specifically what are the impediments to ES becoming accessible to the widest possible audience, from academics to professionals to laymen? I posit that there are two major stumbling blocks: 1) the difficulty of simplifying complexities between services so that existing institutions

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(including statutory planning) can incorporate the approach, and 2) the lack of cross-landscape unit assessment methods and examples. This paper reviews the historical development of the ES approach focusing on its relevance to applied geography at different stages of its development. It also describes the present state-of-the-art of ES, and synthesizes the results from several seminal papers and reports related to the current challenges mentioned above.

Overview of historical background and evolution

The ES approach rose to prominence starting in the early the 1980s even though references to valuing benefits of natural ecosystems can be found in many earlier publications from various fields (e.g., King, 1966; Ryther, 1969). Within the field of the ecology, there has been recognition of the value of provision of services, functions and structures of ecosystems practically since the field materialized. As early as 1948, Rachel Carson alluded to these services when writing simply about wildlife conservation: "For all people, the preservation of wildlife and of wildlife habitat means also the preservation of the basic resources of the earth, which men, as well as animals, must have in order to live. Wildlife, water, forests, grasslands – all are parts of man's essential environment"(Carson, 1948).

In recent years the ES approach has become a conceptual and empirical link between ecological health and human wellbeing and a vehicle with which to communicate the importance of nature conservation to policy makers and the general public (Carpenter et al., 2009; Collins et al., 2011; Daily, Kareiva, Polasky, Ricketts, & Tallis, 2011; de Groot, Alkemade, Braat, Hein, & Willemen, 2010). The approach has evolved significantly over the past three decades while exhibiting advances on a number of fronts throughout this period.

In the early days, following the publication of seminal breakthrough articles, particularly *Nature's Services* (Daily, 1997) and a cover story in *Nature* (Costanza et al., 1997), ecosystem services became hot news. Stories broke through to the media on the importance of ecosystem services and were featured shortly thereafter in *Newsweek* and in *The New York Times*, on radio talk shows and even in a segment on television's "Nightline" (Salzman, 1998). Developments from various fields led to this broad interest and similarly emanated from the innovative synthesis of economics and ecology (Pimm, 1997). Such developments fit well with neoliberal economics gaining ground in the last decade of the last century. They included the maturation of the field of conservation planning that incorporated the premise that specific regions, areas and landscape types can be clearly valued more than others (e.g., Olson & Dinerstein, 1998). This has close connections to the geographic-dependent, place-based, spatial prioritization techniques with foundations in biodiversity conservation that have continued to gain ground and are contributing to work on restoration ecology, complementarity and resilience (Moilenan, Wilson, & Possingham, 2009).

Other subsequent developments have been the extensive work on particular services, such as crop pollination (e.g., Kremen, Williams, Bugg, Fay, & Thorp, 2004), water flow and hydropower production (e.g., Guo, Xiao, & Li, 2000), and recreation (Naidoo & Admowicz, 2005). A ground-breaking advance on the institutional and social change front has come from the emergence worldwide of small-scale systems of payments for ecosystem services (Food and Agriculture Organization (FAO), 2004). However such arrangements require motivated sets of resources managers to participate in such policies (van der Horst, 2011) and for scaling up, they require complex diplomacy and broad consensus of how to go about ESA.

Another aspect, one related closely to developments in the field of geography, has been the increasing use of GIS and other geospatially advanced methods of analysis for ESA. This includes various types of digital cartography, remote sensing, photometric image analysis, and technologies such as simulation visualization and augmented reality that can be adapted for application to spatial problems. Over the past three decades, GIS applications have become basic tools accessible to professionals beyond highly trained geographers. There have been great improvements in recent years in computer software and hardware, spatial databases and targeted applications that have the facilitated implementation of ESA. One prominent example of the latter is InVest developed by the Natural Capital Project (see Nelson et al., 2009). Generally, such GIS applications, specifically developed for ESA, support overlay analysis that combines data layers, developed through the use of complex modeling algorithms, into composite maps (Hinojosa & Hennermann, 2012; Ng, Xie, & Yu, 2013; Norman, et al., 2012; Sherrouse, Clement, & Semmens, 2011). Temporal and spatial trajectories can then be applied and adjustments made as new information becomes available.

Parallel to these advances, a number of seminal reports catapulted the ES approach into the mainstream of conservation planning and helped propel the concept to prominence in the academic and policy-making communities. The most influential report has been the Millennium Ecosystem Assessment (MEA) carried out during 2001–2005 under the auspices of the United Nations (UN). Its mandate was to establish the scientific basis for actions needed to enhance the conservation and sustainable use of ecosystems and their contributions to human well-being. It provides management options and future scenarios for policy makers to consider.

Other initiatives that have made substantial contributions to the ES approach are the work of the Economics of Ecosystem and Biodiversity (TEEB) group. With offices and support coming from the UN Environmental Program (UNEP), TEEB is a global initiative focused on drawing attention to the economic benefits of biodiversity. TEEB's first influential document was the interim report of their study on the economic significance of the global loss of biological diversity published in 2008 (TEEB, 2008). Their work has led to progress on ES such as a standardized classification scheme for valuation (mentioned below) being discussed in the context of the System of Environmental-Economic Accounts of the UN Statistical Division (Haines-Young & Potschin, 2010).

These efforts were accompanied by the concurrent establishment of the UN Intergovernmental Platform on Biodiversity and Ecosystem Services in 2010, and the increase in national-scale ES assessments like those in Great Britain (UK National Ecosystem Assessment, 2011) and Japan (Japan Satoyama Satoumi Assessment, 2010). Recently the European Community has called on its member states to map and assess the state of ecosystems and their services in their national territories with the assistance of the European Commission (Action 5 of the EU Biodiversity Strategy to 2020).[1]

A new discussion paper that serves as a toolkit for implementation of the ES approach (European Commission, 2013) proposes a typology of ecosystems to be assessed and mapped. It also proposes the use of the Common International Classification of Ecosystem Services (CICES) developed for environmental accounting purposes. This is an important step for progress towards a

[1] Action 5 of the Biodiversity Strategy requires Member States to map and assess the state of ecosystems and their services in their national territories by 2014 and to promote the integration of these values into accounting and reporting systems at national levels and at the EU level by 2020 (European Commission, 2013).