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A research agenda for ecosystem services in American environmental and land use planning

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ABSTRACT

We assess pathways for integrating the ecosystem services concept into American land use and environmental planning. Ecosystem services are the beneficial products that functioning ecosystems provide to human society. Building on Ian McHarg's influential ecological planning work, we argue that ecosystem service-based planning frameworks may improve our understanding of the consequences of planned actions in urban-ecological systems. Using evaluations of four diverse and innovative comprehensive plans, we examine how ecosystem service information can enhance plan specificity, investment strategies, and prioritization for policy implementation. Finally, we present a research agenda for evaluating how the use of ecosystem services in planning could improve assessment and communication of planning tradeoffs and outcomes.

1. Introduction

In 2001, the United Nations Environmental Program convened over 1350 experts from 95 countries to review the state of Earth's ecosystems and the consequences of human activity on environmental functions (Millennium Ecosystem Assessment; MEA, 2005). They found that alterations to the world's ecosystems over the past 50 years outpaced those of any other point in human history. Growing demands for clean water, food, and fuel threaten to inflict irreversible losses to global ecosystems. Ecosystem services (ES) – defined as the beneficial functions supplied to human society by ecosystems – served as the organizing framework for the UN initiative and now serve as the primary theoretical construct for vast research literature spanning many disciplines, including an entire area of ecological inquiry that focuses on the linkages between human well-being and ecological function (Seppelt, Dormann, Eppink, Lautenbach, & Schmidt, 2011).

As demonstrated by the MEA initiative, ES offer a conceptual framework for explaining and understanding the connection between human activities and the complexities of environmental degradation (Yap, 2011). Building on this, numerous communities across the United States have begun to analyze ES to better understand the role and functioning of their natural resources, and thereby improve urban decision-making processes. For example, King County, Washington performed an analysis of potential development futures for Maury Island, determining that certain zoning decisions could have disproportionately extensive impacts on the ecological benefits of coastal, riparian, and freshwater wetlands, leading to stability problems in beaches, sedimentation, reductions in wildlife abundance, and other impacts (Herrera Environmental Consultants et al., 2004). This analysis allowed King County to move beyond vague discussions about resource quantity and location, and talk more directly about what, where, and how those ecosystems provided benefits to surrounding residents.

In the United States, the profession and practice of city and regional planning contributes to the creation and implementation of policies that help govern urbanized and rapidly urbanizing environments (Berke, Godschalk, Kaiser, & Rodriguez, 2006). Although the planning profession is far from the last voice on regulatory, conservation, or development decisions, the profession's role in the translation of community goals into policies is an opportunity to influence decision-making within the urban land development process. The connection between the ecosystem service and planning professions, however, has been predominately unidirectional (BenDor & Doyle, 2010; Berke, Spurlock, Hess, & Band, 2013). Ecosystem service studies frequently reference planning efforts and the impacts of urban decisions on ecological functions, but – save for several examples, such as those above – it is rare for this information to be fed back into planning practice as a mechanism for development and land-use decisions (e.g. Chan, Shaw, Cameron, Underwood, & Daily, 2006). While there is a long history of planning recognizing the benefits of functioning ecosystems, there are few examples in the U.S. of plans explicitly using an ES framework (Wilkinson, Saarne, Peterson, & Colding, 2013).

Most land use and comprehensive plans are based on inventories of land uses, types, and resources (Berke et al., 2006; Kaiser & Godschalk,

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1995) that consist of basic assessments of quantity, such as open space acreage, miles of trail resources, or wetland acreage. While useful, these coarse measurements can neglect the quality and health of ecosystems (Mertes & Hall, 1995) and do not differentiate based on the type or provision of services to people (the MEA (2005) delineates ES into provisioning, regulating, supporting, and cultural services). For example, instead of looking merely at forest acreage or wetland classification during a planning process, using ES-based analysis might investigate stormwater storage, nutrient uptake, or air quality improvements, which are dependent on vegetation level and type.

High resolution, disaggregated environmental data can facilitate measures of ecological quality, analysis of tradeoffs, and exploration of complex spatial relationships during decision-making process (Benedict & McMahon, 2006). In the planning context, ES based approaches may pave the way towards development designs and plans that maintain ES, while meeting other objectives for economic development, transportation, agricultural production, and other needs. It's important to note that, while many ES investigations often lead to valuation efforts as a means to differentiate between different decisions (e.g. King County; [Herrera Environmental Consultants et al., 2004]), the recognition of ES benefits does not need to be restricted to quantification and valuation in order to provide distinct advantages to decision processes. (Olander, Boyd, & Schieffer, 2015; Olander et al., 2015). Although an ES approach may be more data heavy, this information is theoretically much more applicable to the public in conveying tradeoffs associated with different courses of action (e.g. discussing "flood water reductions" with a non-expert may be easier than explaining "hectares of wetlands.")

Both Ian McHarg's work and more recent research support the explicit incorporation of ES into planning. *Design with Nature* provided an early example of how ecological information could be incorporated into land-use and design decisions without the explicit label of ES. More recent studies propose the modification of existing frameworks such as multi-criteria decision analysis and the development of new frameworks to integrate ES into land-use planning and decision-making (Albert et al., 2016; Biggs, Schlüter, & Schoon, 2015; Langemeyer, Gómez-Baggethun, Haase, Scheuer, & Elmqvist, 2016; Nin, Soutullo, Rodríguez-Gallego, & Di Minin, 2016). Yet, studies that explore the integration of ecological information into comprehensive plans suggest that the inclusion of ecological data is woefully inadequate (Berke et al., 2013; Brody, Highfield, & Carrasco, 2004). Additionally, few studies on urban ES provide recommendations to policy makers about how to implement an ES framework into decision-making (Haase et al., 2014). These findings suggest there are opportunities to provide explicit guidance on how to incorporate ES into planning with the goal of balancing urbanization and environmental degradation.

A focused examination of how planning can integrate ES information, theories, and models is necessary. While multiple initiatives seek to integrate ES into decision-making such as *The Economics of Ecosystems and Biodiversity* (TEEB, 2011) and the *Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services* (IPBES; Díaz et al., 2015), questions remain about what an ES framework would look like for planning and the benefits of such an approach to planning practice. In this paper, we assess the potential for integrating the ecosystem services concept into land use and environmental planning in the United States[1] and explore the potential opportunities and negative consequences presented by this approach. By "ES framework," we reference the use of ecosystem service concepts, measurements, theories, and models as a major factor in analyzing planning decisions, engaging in planning processes, and making recommendations for future action. In particular, we seek to explore several key questions, including:

1) What would it entail to incorporate a significant amount of ecosystem service information into land use and environmental planning? How could an ES framework differ from existing paradigms for incorporating environmental quality measures into planning?

2) Could the ES paradigm be constructed as an organizing framework for analyzing tradeoffs in alternative decisions during the land use and environmental planning process? What are the benefits and consequences of utilizing ES as an input into the land use and environmental planning process?

We begin the paper by reflecting on Ian McHarg's ground-breaking push for urban designs that harmonize with environmental features, and then contrast his work with recent advances in analysis of ecosystem service tradeoffs. In the 46 years since McHarg's (1969) *Design with Nature*, ecological science has advanced our scientific understanding of – as well as our ability to discriminate, weigh, and model – the environmental implications of urban land use choices. We reflect on McHarg's observations to address the first research question in light of the growing body of measurements and methods for weighing the importance accorded to different services by different stakeholders.

To investigate the second question, we analyze comprehensive plans from four communities, which were selected on the basis of their representation of and acknowledged leadership in four fields: a hazard-mandated land use plan (New Hanover County, NC), a major metropolitan land use plan (Philadelphia, PA), an ecosystem-service based plan (Damascus, OR), and a county plan in a heavily regulated watershed (Baltimore County, MD). We compared these plans on three factors (quality of ES information, tradeoff analysis, and stakeholder engagement) to illustrate the shortcomings of existing planning approaches and the potential advantages of an ES framework. These cases help highlight the multitude of obstacles that may prevent the incorporation of ES into the planning profession.

Finally, drawing on the previous sections, we propose a focused research agenda that will inform and guide the integration of ES as a vector for promoting better decisions in environmental planning practice. In this agenda, we explore a number of lingering questions that stand between planners and the widespread use of ES as a supporting framework for modern land use and environmental planning.

2. Ecosystems in planning: McHarg and beyond

There is a long history of exploring stronger and more sophisticated integration of environmental considerations into planning policy and decision-making. In his 1969 book, *Design with Nature*, Ian McHarg, articulated design approaches and planning processes to shape urbanizing landscapes while promoting protection of natural resources. While many additional frameworks for 'ecological' planning have been advanced (e.g. Roseland, 1997; Vasishth, 2008), McHarg's work remains an authoritative contribution with an enduring influence at the interface of the ecology, planning, landscape architecture, and architecture fields (Steiner, 2006). We will therefore draw on McHarg's opus as a proxy for much of the subsequent direction of the ecological planning literature.

In his most famous example, McHarg focused on the important role dunes play in protecting coastal areas in New Jersey from storm surge. He first vividly described the ecological processes that create and maintain dunes and then investigated the tolerance of dune environments to development. Accounting for the tolerance of the dune system, McHarg provided a loose outline for the design of a built environment that balanced the protective services of dunes with other human benefits such as recreational access. His takeaway message from the dune and other examples, was that the many social values provided by nature can be balanced through the use of ecological data during the process of designing the built environment: "…[I]t is enough to observe that [the ecological view] could considerably enhance the present mode of

[1] We limit our analysis in this document to the American planning process, which observes various procedural, cultural, and legal hallmarks, including mandated public participation, budgetary and legal federalism, property rights concerns, constitutional obligations to due process and equal protection, and a consistent focus on local-government obligations to protect health, safety, and welfare.