A demand driven research agenda for ecosystem services

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1. Introduction

Current research on ecosystem services disproportionately focuses on supplying ever more information about the value of ecosystem services and less on a systematic, scientific understanding of the demand by decision-makers for such information. The field remains stuck in a supply side paradigm that assumes more sophisticated models about the supply and value of ecosystem services will lead to policy change. Because the supply-side is vast, a clear path forward has not emerged about what to value and at what level of accuracy. Thus our understanding of ecosystem services remains piecemeal and highly variable. We argue that to accelerate the adoption of the ecosystem service framework in practice, the research community needs to shift its attention to policy choices and the demand for data about ecosystems (Cowling et al., 2008; Menzel and Teng, 2009).

2. The supply side paradigm

The existing supply side paradigm usually begins with the biophysical functioning of an ecosystem and subsequently attempts to integrate economic values. The predominant conceptual model suggests that research on ecosystem services should flow from [Ecosystem Functions & Structures] to [Ecosystem Services] to [Economic Values] (Daily et al., 2009; Haines-Young and Potschin, 2010). While conceptually sound, if research is executed in this order it can often be divorced from the needs of decision makers because the focus remains either on the ecological process or the numerical valuation. Better information about ecological processes or abstract valuations will not spur better decision-making. Despite a large and growing body of studies on the supply of ecosystem services, ecosystem services thinking and information is still not being used by the decision makers who need it (Daily et al., 2009; Laurans et al., 2013). Supply-side valuations tend to be either (1) large scale aggregations of ecosystem services (e.g. Costanza et al., 1997; de Groot et al., 2012) which are good for raising awareness, but not particularly useful for policy, or (2) smaller scale valuations of a subset of ecosystem services that provide values for some ecosystems but not others. For instance, Pendleton et al. (2007) found that in the United States there are many monetary valuations of beaches and recreational fisheries, but few of coastal wetlands. The choice of what to value stems more from researcher location and interests than it does from policy demand (Pendleton et al., 2007). Not only does this approach leave many important ecosystem services and tradeoffs unvalued, but an incomplete set of valuation estimates can be problematic for policy makers. How should budgetary allocations be made when policy makers only have valuation estimates for a subset of ecosystems? For instance, the Acting Chief Economist at the National Oceanic and Atmospheric Administration has struggled to communicate the value of sea grasses, salt marshes and muddy-bottom habitats in the shadow of large valuation estimates for corals.

Conservation biologists and interdisciplinary scientists first advocated for the ecosystem service framework in order to put forward stronger arguments for ecosystem protection. This legacy has created a bias that favors methods and approaches steeped further in the biophysical sciences rather than the social sciences. New software has also made it easier to model and “predict” the supply of ecosystem services (Boumans et al., 2002; Tallis et al., 2011). Advances in modeling and geographic information systems have led to the creation of specialized programs that calculate the ecosystem services generated from specific land units (Bai et al., 2011; Nelson et al., 2009). Of course, these models are only as good as the data that underpin them. While these data are improving, they generally suffer from (a) the need to use data collected for other purposes (benefits transfer), (b) a weakness in the underlying biophysical model that does not fully capture the complexity of the ecological system (Norgaard, 2010), and (c) a human-use model that is overly simplistic and fails to consider the complementarity of human factors that help create ecosystem service uses and values. Models will be limited in their policy effectiveness if they fail to capture how humans interact with each other, how tradeoffs are made between resource users, and how non-environmental factors influence ecosystem values and decision-making.

3. The demand for information on ecosystem services

In the absence of a full catalog of ecosystem service values or models that are sufficiently comprehensive for all decision-making, we need a system of policy triage to guide research on ecosystem services. This system of prioritization should begin with decision makers and resource users. In particular, we should start by studying the demand for information about ecosystem services and give priority to questions that can best be answered with better information. We believe that there is a demand among many decision makers for more targeted science on ecosystem services (Tallis et al., 2008; Holdren and Lander, 2011) and meeting this demand will advance the application of ecosystem service thinking in the policy world.

A demand-driven research agenda focuses on how people might use ecosystem services information. Acting on this agenda requires that we pay special attention to the political, cultural, technological and economic context. For example, water managers

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in New York City succeeded in developing a drinking water protection strategy based on the notion of ecosystem services precisely because they understood the demand for these services, the technology used, and the political realities involved in striking a deal with upstream land owners (Elliman and Berry, 2007).

Decision makers often need information about ecosystem services even if they do not use this language to describe their policy agenda. For instance, coastal managers in the Mediterranean are hard pressed to understand the ecosystem structures and functions that would reduce jellyfish blooms that> provoke beach closures (Rosenthal, 2008a). Similarly, city managers often seek to understand how land management practices might reduce the risk of flooding (Stevens, 2010). In both instances, resource managers have established policy goals that may be achieved by managing ecosystem services effectively. While it is tempting to value the world's ecosystems (de Groot et al., 2012) or ponder the collapse of global fisheries (Worm et al., 2006), such large scale values and events are rarely relevant to real world decisions. Thus the demand-oriented approach we propose is likely to entail scaling down to spatial scales that are relevant for local users (Hein et al., 2006).

Furthermore, we must engage ecosystem managers and resource users *prior* to modeling ecosystem service production. Modeling tools are more likely to be useful if they address questions that have emerged from policy processes. We call for stakeholder engagement that would go beyond the collection of opinions from policy makers, the private sector and local ecosystem users, and would include structured and scientific methods to allow the needs of resource users and managers to help guide our research agenda (Talberth et al., 2013). Modest engagement with stakeholders is likely to be insufficient. To be fair, some researchers have begun to examine the demand for ecosystem services more carefully (Kroll et al., 2012; Bagstad et al., 2013), but the field still tends to focus on the biophysical supply of services and new valuations rather than matching ecosystem values to emerging policy decisions (Balvanera et al., 2012).

By advocating for a demand driven research agenda, we are not arguing that we should abandon research that seeks to better understand the ecological underpinnings of ecosystem service production. Nor are we suggesting that policy makers cannot learn from science that uncovers new human dependencies on ecosystem processes. We are arguing, though, that a failure to focus on the needs of decision makers has diminished the policy usefulness of ecosystem service research and has limited the appetite of policy makers to use ecosystem service information.

A demand driven research agenda will require the scientific community to adapt to the needs, spatial scales and timeframes of decision makers. The methods and techniques used to engage decision makers differ considerably from those used in the physical sciences and are best applied by social scientists. We need to avoid the notion that the rest of the world needs to adopt our terminology and world view. Rather than have one conceptual model of ecosystem services and one lexicon of ecosystem terminology, we may need multiple vocabularies that more effectively connect our work to those that stand to benefit from our research.

Substantial progress has been made in the science of ecosystem services, but the field remains lopsided, producing a disproportionate number of studies that quantify the supply of ecosystem services or estimate ecosystem service values. We cannot afford to miss the abundant and growing demand by decision makers who want to use ecosystem services thinking to help solve their problems.

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