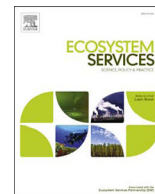




Contents lists available at ScienceDirect

Ecosystem Services

journal homepage: www.elsevier.com/locate/ecoser

Knowledge needs for the operationalisation of the concept of ecosystem services

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ARTICLE INFO

Article history:

Received 1 December 2016

Received in revised form 7 October 2017

Accepted 18 October 2017

Available online xxx

Keywords:

Ecosystem services

Operationalisation

Knowledge needs

Transdisciplinary research

ABSTRACT

As environmental challenges and their management are increasingly recognised as complex and uncertain, the concept of ecosystem services has emerged from within scientific communities and is gaining influence within policy communities. To better understand how this concept can be turned into practice we examine knowledge needs from the perspective of the different stakeholders directly engaged with the operationalisation of ecosystem systems concept within ten socio-ecologically different case studies from different countries, levels of governance and ecosystems.

We identify four different but interrelated areas of knowledge needs, namely; (i) needs related to develop a common understanding, (ii) needs related to the role of formal and informal institutions in shaping action on the ground, (iii) needs related to linking knowledge and action, and (iv) needs related to accessible and easy to use methods and tools. These findings highlight the need to view knowledge as a process which is orientated towards action. We discuss the potential to develop transdisciplinary research approaches and the development of tools and methods explicitly as boundary objects in the ecosystem service science community to develop more collaborative practices with other stakeholders and facilitate the operationalisation of the concept of ecosystem services across contexts.

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1. Introduction

Environmental challenges and their management are increasingly recognised as complex and uncertain. As our understanding of these issues increases so does our awareness of the gaps in our knowledge and the need to address these gaps to increase societies' capacity to manage these issues effectively (Van Kerkhoff and Lebel, 2015; Pahl-Wostl, 2009). In addition to the need to develop scientific ecological understanding, the importance of understanding social and institutional processes, the interactions between

governance levels, policy sectors and the need to include a broader range of stakeholder groups and their goals and values is recognised to help shape action that protects ecosystems (Wyborn, 2015b; Carmen et al., 2015; Prager et al., 2012). It is within this backdrop that the concept of ecosystem services, which presents a more integrated, systematic view coupling social and ecological components into one system, emerged from within scientific communities and is gaining influence within policy communities (Carpenter et al., 2009). The aim of this paper is to examine knowledge needs from the perspective of the different social actors directly engaged in decision making processes aimed at applying the concept of ecosystem services to better understand how the concept of ecosystem services can be operationalised and turned into practice more widely.

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The ecosystem services concept focuses attention on the fundamental links and feedbacks between nature and society (Mace et al., 2012). Specifically the concept frames these links in terms of the benefits derived from ecosystem functions and processes to diverse social groups (Hauck et al., 2013). Critically, the main aim behind the development of the ecosystem services concept has been to more explicitly incorporate environmental dimensions into decision making and action (Daily et al., 2009), thus operationalising the concept of ecosystem services into practice.

Within the scientific community there has been a focus on developing various frameworks, knowledge and tools to assess and quantify these benefits (Bagstad et al., 2013). This has resulted in new collaborations, particularly between economists and ecologists to develop tools and knowledge on the economic value of ecosystem services, reflecting the increasing recognition of the need to work across disciplinary boundaries within scientific processes relating to the ecosystem services concept (Cornell, 2011). These developments have contributed to our understanding of the dynamics of different socio-ecological dimensions across contexts, but to a lesser degree have helped developed our understanding of the social and institutional factors that shape decision making processes, environmental practice and change processes more broadly to improve socio-ecological outcomes (Luederitz et al., 2015).

We use the term 'knowledge needs' to refer to the emerging recognition of different gaps in our capacity to help turn the concept of ecosystem services in practice. In this study we provide empirical evidence of these knowledge needs. First, we briefly outline the different conceptualisations of knowledge, highlighting different and often overlapping interpretations of knowledge, and current focus of enquiry in the ecosystem services science community. Secondly, we explain the inductive approach taken in this study to identify knowledge needs from the perspective of the multiple stakeholders involved in case studies driven by the ecosystem services research community and of EU level policy experts. Thirdly, we present our findings organised around four key themes identified from the data. Lastly, we examine the implications of these findings for scientific communities to help facilitate the operationalisation of the concept of ecosystem services in practice. Specifically, this focuses on a critical reflection of knowledge production processes in a scientific context.

2. Conceptualisations of knowledge

2.1. Different types of knowledge

Knowledge is not easy to define and, as such, has led authors to conceptualise it and classify it in a variety of ways (Nutley et al., 2007). This includes distinguishing between traditional ecological knowledge and scientific knowledge (Berkes et al., 2000). Nutley et al. (2007) highlight distinctions made between empirical, theoretical and experimental knowledge. Empirical knowledge is often the most explicit and based on quantitative or qualitative research. Theoretical knowledge relies on theoretical frameworks (Potschin-Young et al., 2018) for thinking about problems either informed by research but more often than not based on intuition and informal approaches. Finally experimental knowledge, which is often tacit, based on practice implicitly accumulated through operational experience from routines and behaviours in particular social setting, and more challenging to articulate (Fazey et al., 2006; Boiral, 2002). Vink et al. (2013) distinguish between organised knowledge and unorganised knowledge. Organised knowledge being characterised as formal knowledge involving a wide consensus and therefore stability of understanding often crystallized in written or modelled form. Unorganised knowledge is characterised

as involving collective puzzlement whilst moving towards wider agreement through interactive processes involving deliberation, learning and sharing. Failing et al. (2007) distinguish between fact-based knowledge claims and value based knowledge claims, the former referring to descriptive claims about the way the world is or might be and the latter referring to normative claims about how things should be, thus presenting more explicitly that knowledge is contested. It is however now more commonly agreed that knowledge is socially constructed and value laden (Adams and Sandbrook, 2013) and cannot be separated from its social and political context (Hannigan, 1995). Importantly, different types of knowledge are not mutually exclusive, rather knowledge is a continuum, for example between explicit and tacit knowledge or unorganised and organised knowledge, thus approaching knowledge as a static product may be overly restrictive (Boiral, 2002).

2.2. Knowledge production processes

Moving away from the linear, positivist view of knowledge as a static, tangible product that is easily defined and articulated which can then be readily inserted into decision making processes, there is an increasing focus on the flow of knowledge, as a dynamic, interactional process (Fazey et al., 2014). For example, through interactions between science, policy and practitioner communities to frame knowledge as a problem oriented process or the coming together of people and practices from different social groups to work together to produce new knowledge for mutual benefit and to facilitate change (Waylen and Young, 2014; Van Kerkhoff and Lebel, 2015; Rosendahl et al., 2015). In this study we use this broader, processes based perspective of knowledge. The broader perspective that views knowledge production as an interactional process is often referred to as knowledge co-production, where multiple stakeholders work collaboratively to share, explore, learn and shape new knowledge orientated around a real world problem. More broadly if this approach is taken in research it is referred to as transdisciplinary research and represents a deliberate lack of any clear boundary between 'science' and 'policy' and 'experts' and 'users' in the collaborative production of knowledge (Wyborn, 2015a; Lejano and Ingram, 2009). This process-based perspective explicitly recognises different perspectives, knowledge gaps, uncertainty and thus not only known unknowns, but also unknown unknowns (Luks and Siebenhuner, 2007; Pawson et al., 2011). Importantly this methodological shift to a more process-based perspective of knowledge in research is often defined as a move from *mode 1* knowledge production, which involves the research community organised into disciplines objectively examining the outcomes of change, towards *mode 2* knowledge. *Mode 2* knowledge processes explicitly recognise subjective perspectives and mutual dependence between different social groups in society, and thus emphasises the importance of involving them in knowledge processes across different applicable contexts (Buizer et al., 2011; Lemos and Morehouse, 2005; Lang et al., 2012). One example of an approach that embodies *mode 2* knowledge is adaptive co-management (Stringer et al., 2006; Armitage et al., 2009). However, a gap has been identified in many studies between the rhetoric of this approach and its application (Plummer and Armitage, 2007). This has led to calls for a focus on the methodological assumptions underpinning adaptive management, moving away from viewing ecosystem management as a technical problem towards broader perspectives that also embrace the social and institutional factors that shape these processes (Plummer and Hashimoto, 2011; Cundill et al., 2012). As a concept that embodies the need for an integrated approach, the operationalisation of the ecosystem services concept into decision making is also an excellent example of such an applicable context.

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