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Embedding the concept of ecosystem services? The utilisation of ecological knowledge in different policy venues

Andrew Jordan
Tyndall Centre, School of Environmental Sciences, University of East Anglia, Norwich NR4 7TJ, England; e-mail: a.jordan@uea.ac.uk

Duncan Russel
Department of Politics, University of Exeter, Exeter EX4 4RJ, England; e-mail: d.j.russel@exeter.ac.uk
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Abstract. The concept of ecosystem services is increasingly being promoted by academics and policy makers as a means to protect ecological systems through more informed decision making. A basic premise of this approach is that strengthening the ecological knowledge base will significantly enhance ecosystem health through more sensitive decision making. However, the existing literature on knowledge utilisation, and many previous attempts to improve decision making through better knowledge integration, suggest that producing 'more knowledge' is only ever a necessary but insufficient condition for greater policy success. We begin this paper by reviewing what is already known about the relationship between ecological knowledge development and utilisation, before introducing a set of theme issue papers that examine—for the very first time—how this politically and scientifically salient relationship plays out across a number of vital policy venues such as land-use planning, policy-level impact assessment, and cost–benefit analysis. Following a detailed synthesis of the key findings of all the papers, this paper identifies and explores new research and policy challenges in this important and dynamic area of environmental governance.

Keywords: ecosystem services, knowledge utilisation, governance, sustainable development

1 Introduction

> "Over the past 50 years, humans have changed ecosystems more rapidly and extensively than in any comparable period of time in human history … . This has resulted in a substantial and largely irreversible loss in the diversity of life on Earth."
>
> MEA (2006, page 1)

> "Evaluators need to re-double their efforts to get their message heard. Dissemination is a big job, and informing the whole array of policy actors whom Cronbach … called the 'policy shaping community' *is not a task for odd moments*. Time, thought and energy have to be invested in order to reach the people whose ideas make a difference in policy."
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> Weiss (1999, page 483, emphasis added)

The 2006 Millennium Ecosystem Assessment (MEA) was but the latest in a long line of global environmental assessments sponsored by the United Nations. It highlighted the impact that human activities have had (and appear likely to have) on ecological systems. More specifically, it demonstrated that 60% of the services that ecosystems provide to society were degraded and/or being managed unsustainably. This state of affairs, it claimed, could have a detrimental impact on human well-being and development, particularly amongst the poor who rely directly on ecosystem services for their survival. A similar prognosis was delivered in the United Kingdom's National Ecosystem Assessment (NEA), one of very few national-level follow-ups to the MEA. It demonstrated that the ability of UK ecosystems to deliver such services has declined dramatically over the past sixty years.

The MEA provided an unprecedented overview of the state of the world's natural environment and, more saliently for our purposes, enshrined the basic idea that ecosystem value in decision making should be based on the idea of services provided to humans. This idea is a key tenet of the increasingly fashionable concept of ecosystem services. The MEA and the NEA have undoubtedly generated much new knowledge about the functioning of ecosystems (Haines-Young et al, 2015; Potschin and Haines-Young, 2011). But scholars of knowledge development and its (non)utilisation have argued for some time that generating 'more knowledge' does not necessarily mean it will actually be used by decision makers. It was for this reason that Weiss (1999), cited in the epigram of this paper, referred to the need for patient and sustained work at the boundary of science and policy. She was of course writing from the perspective of an entirely different literature—one that contains rather pessimistic and sceptical references to the myriad gaps, missing links, and noneffects that characterise the relationship between the production and utilisation of knowledge (Fazey et al, 2012; Haas, 2004; Lemos et al, 2012; Rich, 1991). The 'problem of little (knowledge) effect' has been reported in many academic fields (Weiss, 1979) including geography, policy, and public administration (Owens, 2005; Sanderson, 2002; Weiss, 1979). Indeed, for Caplan (1979), knowledge producers (ie, typically scientists) and knowledge users (ie, policy makers but especially politicians) inhabit entirely different communities or worlds, which all too often speak past rather than to one another. The sad and rather dispiriting truth to emerge from the knowledge utilisation literature is that "large quantities of knowledge produced for the benefit of policy are *never used*" (In't Veld and de Wit, 2000; quoted in Owens, 2005, page 287, emphasis in original; see also Haas, 2004, page 571; Lemos et al, 2012, page 789).

2 Theme issue: aims and objectives

In comparison with the richness of the discussion in other policy areas, the debate within the ecosystem services community about the conditions in which new knowledge is or is not used, by whom and for what purpose, has barely even begun. In fact, as we note above, the literature on these topics is still rather patchy, hence the need for this theme issue (for exceptions, see Ferraro et al, 2011; Laurans et al, 2013; Russel et al, 2014).

Our starting point in this introductory paper is that understanding *how*, *by whom*, and *in which context* (or policy-making 'venue') ecological knowledge (including that on ecosystem services) is embedded in decision making is a vital challenge for scientists and policy makers concerned about the diminution of global ecosystems. Of course, this endeavour necessitates building on all the excellent work that has already been done to develop the science and economics of ecosystem services. But it also requires a much more 'serious' (Norgaard, 2010, page 1225) look at the role of policy, politics, knowledge production, and, of course, knowledge utilisation. A fresh look would involve recognising that ecosystem services thinking is not occurring on a tabula rasa—or a policy–institutional 'void' (Hajer, 2003)—but in a landscape crowded with existing institutional forms, many with different (and often avowedly *non*ecological) functions and purposes. It is important, we contend, that the ecosystem services community better understands how the new and existing forms of knowledge intermingle and coevolve.

The knowledge utilisation literature broadly accepts that 'context matters'; where, when, and how utilisation occurs shape the extent of use (Head, 2011; Nutley et al, 2007, page 303). In this theme issue we develop this basic idea by examining the processes of ecological knowledge utilisation across different policy venues in the UK. In principle, there are many different *venues* in which the embedding of ecological knowledge into policy could occur (Jordan and Turnpenny, 2014). These include expert advisory bodies, parliamentary committees, policy appraisal, and land-use planning (see, for example, Craft and Howlett, 2012). These correspond to what Baumgartner and Jones (1991, page 1045, emphasis added) have termed the "*venues* of policy action". They subsequently referred to these venues as "institutional locations where authoritative decisions are made concerning a given issue" (Baumgartner and Jones, 1993, page 32). We define policy formulation venues more specifically as: "institutional locations, both within and outside governmental settings, in which policy formulation tasks are performed, with the aim of informing the design, content and effects of policy making activities" (Jordan and Turnpenny, 2014, chapter 1). The venues exist at different levels of governance (nation-state versus supranational and subnational); and within or outside the formal structures of the state.

These venues can, as noted above, have a marked impact on the patterns of use and nonuse (Head, 2011). For example, they may each have specific models of processing and utilising knowledge based on their standard operating procedures and accepted framings of policy problems (Rich, 1991). Moreover, different venues may prioritise different kinds of knowledge depending on, among other things, their core mission and whether they are in the public, private, or third sectors. In turn, they may attract different constellations of actors and power relationships that can influence knowledge utilisation in both positive and negative ways. Furthermore, venues at different levels of governance typically seek out different types of knowledge. For example, actors at European Union and UK levels of decision making tend to seek out a more strategic overview of drivers and impacts (Turnpenny et al, 2008; 2014); planners at the regional level, on the other hand, are more likely to seek a balance between development and environmental protection needs in more specific situations (Cowell and Lennon, 2014; Owens and Cowell, 2010); and those charged with implementing policy at the 'street' level tend to be influenced by client groups and stakeholders (Haines-Young and Potschin, 2014; McKenzie et al, 2014).

Thus far, we have presented knowledge—the second core concept used in the title of this paper—as though it is monolithic, when in fact it often comes in many different forms (Rich, 1991, page 14). The links between it and evidence and research are often complex and contested by different actors. Nutley et al (2007, page 23), for example, argue that research is one type of evidence, and that evidence is one source of knowledge. For the purposes of this theme issue we mainly concern ourselves with the use of *ecological knowledge* expressed through the framework and the language of ecosystem services. Indeed, the language of services is often deliberately used by scientists and environmentalists with the precise aim of tailoring ecological knowledge to users, particularly policy makers and politicians, who often have economic and social concerns as their main priority. We note that such knowledge is not a neutral package of 'facts'; on the contrary, what counts as knowledge and how it is presented (for example, in terms of the 'services provided') is an inescapably political act, which we have asked the authors of the papers to critically reflect upon. The papers reveal (not surprisingly) that by no means is all the knowledge used necessarily scientific and that in reality there are in fact many ways in which 'services' can be presented (eg, in more economic, cultural, and ecological terms—on which more below) (Waylen and Young, 2014). However, given the basic nature of the topic (spanning ecosystems, the environment, ecology, etc), the papers mainly focus on research and scientific knowledge.

Finally, 'embedding'—the third term used in our title—seeks to problematise the use to which new or reformulated knowledge is put (Nutley et al, 2007, page 298). As Rich (1997, page 15) notes, 'use' is not an "all-encompassing concept". Consequently, mapping the extent and pathways of knowledge utilisation ultimately depends on what types of knowledge are being investigated, what the analyst means by ‘use’, and whether they see knowledge utilisation as an ‘outcome’, a ‘process’, or some combination of the two (page 12). Rich (1997, page 15) usefully distinguishes between four main types: (1) ‘use’ in terms of knowledge having been received and read; (2) ‘utility’ representing a user’s judgment that knowledge has potential value but the specific purpose is yet to be identified; (3) ‘influence’ indicating that knowledge has contributed to a decision; and (4) ‘impact’ where information has been ‘received and understood’, leading to clear and concrete policy action. For our purposes, embedding across these four categories should show up across the quadriad of supporting, regulating, provisioning, and cultural services (on which more below).

The papers themselves directly address four main themes. First, they reflect upon what is already known about the use of ecological knowledge in particular venues: what has driven it, through what processes it has occurred, and what effects it has (not) produced. Second, they examine the relatively recent shift towards thinking about ecosystems, principally but not exclusively in terms of the services provided. They investigate what has triggered it and how and in what ways the vexed issue of utilisation has (not) been considered. Third, the papers examine the unfolding experiences of knowledge utilisation across a number of key venues from policy-level impact assessment through to local demonstration projects. All too often, utilisation is considered from the knowledge suppliers’ perspective; but understanding where, when, and how users engage with new knowledge is equally important (Nutley et al, 2007, page 317). Finally, they speculate on the implications of all the findings for future research, theory, and policy practice.

To give the entire collection added focus, we have selected papers which mostly focus on events in the UK. The reasons for this are threefold. First, the UK NEA is one of the first national-level responses to the MEA, and therefore an obvious case to explore as a potential source of transferable policy lessons about ecological knowledge use. Second, the UK is a well-known pioneer of innovative approaches to knowledge-based policy making in environmental (Russel and Jordan, 2009) and many other policy arenas (Sanderson, 2002), many of which have enjoyed very high-level political backing. The NEA was very much developed in that mould; it was designed to open up discussions between scientists and policy makers (Waylen and Young, 2014) rather than “keep science on a tight [political] leash” (Haas, 2004, page 583). Third, through the NEA, an expert community of policy-focused researchers has emerged in the UK—a factor which the literature cites as an important enabler of use. Thus in these three respects, which interestingly span both the supply and the demand side of knowledge development and use, the UK arguably represents a ‘more likely’ case in which to explore the uptake of ecological knowledge.

Before proceeding further, it is worthwhile briefly introducing the seven papers. The first two explore the wider context in which the four themes described above derive their pertinence. In her paper, Dunlop (2014) systematically reviews the existing literature on knowledge utilisation and policy learning, and from it derives some preliminary remarks about its applicability to the field of ecosystem services. In their paper, Waylen and Young (2014) explore the process through which the NEA was established and seek to identify and explain the approach it adopted for facilitating ecological knowledge utilisation.

The other papers examine knowledge utilisation processes in a series of policy venues, which UK policy makers have themselves identified as warranting greater attention in the NEA process. Turnpenny et al (2014) begin by evaluating the extent to which ecological knowledge has been incorporated into national-level policy appraisal processes in the period before and after the NEA. Cowell and Lennon (2014) adopt a different analytical strategy: drawing lessons for the NEA from previous attempts to integrate environmental knowledge into planning processes—that is, they scrutinise the preexisting institutional landscape very much from a user's perspective. They find many previous (and often failed) attempts to employ 'usable' knowledge concepts and categories such as critical environmental capital and ecological footprinting. Hockley (2014) analyses cost–benefit analysis (CBA) as a venue for embedding ecological knowledge, and proposes a series of reforms to enhance its knowledge utilisation potential. The importance of these three venues was, we hasten to add, explicitly noted in the NEA.

Haines-Young and Potschin (2014) focus on the role of knowledge in the implementation of the ecosystem services approach in more informal local venues in England; which, although not labelled as such, embraced a more active form of knowledge exchange or 'brokering' (Ward et al, 2009). Such work was directly funded by the very ministry—the environment ministry—that sponsored the NEA. Finally, McKenzie et al (2014) provide an international perspective through case studies of projects in Belize, Canada, and Hawaii, all of which employed a standardised ecosystem services accounting tool. In the remainder of this paper we first of all sketch out the background to the utilisation of ecological knowledge, including an outline of the concept of ecosystems services (section 3), and then we summarise the key findings that emerge from the papers (section 4) in relation to the four connecting themes identified above.

3 The utilisation of ecological knowledge: framings, venues, and analytical contexts

3.1 Ecosystem services as a framing concept

Sustainability has long been a policy concern both domestically and internationally (Adger and Jordan, 2009). Following the publication of the landmark Brundtland Report, many nations developed governance processes to give environmental considerations a more prominent place in decision making (Bulkeley and Jordan, 2012; Jordan, 2008). However, such approaches have generally been weakly implemented (Jordan and Lenschow, 2008; 2010), and many critical aspects of the planet's natural systems have continued to be degraded by human activities (Rockström et al, 2009). Against this backdrop, new operating concepts and devices—such as resilience (Bulkeley et al, 2013), transitions, innovation (Jordan and Huitema, 2014), and, of course, ecosystem services—have emerged to make sustainability-relevant knowledge more usable (and hence used).

Throughout the 2000s, the framing concept of ecosystem services steadily increased in salience in academic (Hartje et al, 2003) and international circles (CBD, 2000), cumulating in the publication of the global MEA (2006). Central to this way of thinking is the idea that human well-being is dependent on healthy and functioning ecosystems. Simply put, ecosystems services constitute the flow of goods from ecosystems to individuals and society. These services can be broadly categorised into four types: *supporting services* that indirectly influence human well-being through the role they play in underpinning other services—for example, soil formation and nutrient cycling; *regulating services* that are obtained directly from ecosystem processes, including air quality, pollination, and flood defence; *provisioning services* that deliver the direct goods people acquire from ecosystems, including food, fuel, and water; and *cultural services* such as recreation and tourism.

Clearly, knowledge on how ecosystems function, their health, and the services they supply are central to protecting ecosystems. However, the characteristics of ecosystem knowledge are complicated, and epistemic uncertainty is especially high in this field (see Dunlop, 2014). Moreover, knowledge is still rapidly developing and concepts have not yet fully formed, hence continued mixing of normative and empirical claims. Thus knowledge on ecosystems services may, as the papers in this theme issue will powerfully attest to, be very deeply contested (Dunlop, 2014; Hockley, 2014), which does not lend itself to linear and technical forms of knowledge transfer and utilisation.

3.2 Ecosystem services: thinking and practice in the UK

On the back of a strong push from the then United Nations Secretary General, Kofi Annan (2000, page 64), the MEA was commissioned to map the world's major ecosystems services, assess their condition, and explore relevant management options. Comprising 1300 scientists, the MEA quickly became a focal point for many more scientists, who together can now claim to be part of one of the world's largest epistemic communities (Dunlop, 2014). Of course, the MEA was not the only driver of these knowledge development and consolidation activities (Haines-Young and Potschin, 2007); the idea of ecosystem services was also a major pillar of the International Convention for Biological Diversity. The MEA followed a very similar model to that of other assessment processes (eg, the Intergovernmental Panel on Climate Change) in that it sought to systematise knowledge *and* promote awareness, especially amongst policy makers, but *not* specific end users or decisions, as one might expect, where knowledge use is expected to be entirely direct and instrumental (Waylen and Young, 2014). To be fair, the MEA (2006, page 20) noted the importance of ecological knowledge in decision making, but did not fully problematise it by, for example, exploring the conditions in which it was—or was not—likely to be utilised.

Meanwhile, in the UK political support for thinking in terms of ecosystem services was also gaining ground within the UK environment ministry, which in 2007 drew up an action plan on how to embed it in policy making. In addition, following the publication of the MEA, the UK Parliament's Environmental Audit Committee (2006) recommended that the UK government undertake an NEA. The UK government was receptive to the idea, and in 2007 a community of experts commenced work. The NEA was eventually published four years later in 2011 (Waylen and Young, 2014). Like the MEA, the NEA was implicitly but not wholly organised around an instrumental model of knowledge use. However, the NEA (2011) also went a good deal further in seeking to explore and understand knowledge use in more rounded terms than the MEA—that is, it is about new knowledge development *and* knowledge utilisation:

> "Ecosystem services are critically important to our well-being … but are consistently undervalued in conventional economic analysis and decision making" (page 13).

It was, though, subsequently realised that more work was needed to better understand how to embed the NEA's findings in policy. This led to the commissioning of a follow-on assessment—to be published in 2014.

3.3 Knowledge generation and utilisation: theories, concepts, and methods

As we illustrate above, embedding ecological knowledge in different policy venues is not an entirely unique challenge. Knowledge utilisation is the focus of a rapidly maturing academic field (eg, Haas, 2004; Owens, 2005; 2012; Radaelli, 1995; Rich, 1991; Sabatier, 1998; Weiss, 1979), dating back at least forty years (Dunlop, 2014). Crucially, there are many lessons that ecosystem policy makers and researchers can draw from this work, covering many different sectors and policy problem areas (eg, see Nutley et al, 2007).

In her systematic analysis of the field, Dunlop (2014) demonstrates that at the core of knowledge utilisation research field are a couple of hundred articles, many of them directly informed by the work of one woman—Weiss (1979). The field can be sliced in a number of different ways. One way is to organise it around different understandings (or models) of the term 'use'. The classic conception of use in this respect is often based on quite technical matters such as improving the quality of the knowledge collected and tailoring it in a way that policy makers can absorb (Owens et al, 2004). The implicit assumption is that knowledge will flow linearly to rational 'decision makers' who are assumed to demand it to make 'better' decisions and policies (Owens, 2005; Sanderson, 2002; Weiss, 1979). It corresponds to a 'technical rational' (Owens et al, 2004) or 'instrumental' model of use. While there are numerous examples of where instrumental knowledge use has occurred (Haas, 2004; Owens, 2005), the majority of studies suggest the pattern of uptake is highly differentiated, requiring a more nuanced understanding and set of expectations (eg, Hertin et al, 2009; Juntti et al, 2009; Nutley et al, 2007; Owens, 2005; Sabatier, 1998; Sanderson, 2002).

Despite these and other critiques, the technical rational model still has an enduring appeal as an ideal type, particularly amongst economists, scientists, and policy makers (Owens et al, 2006). However, other models of use have been put forward (Dunlop, 2014; Owens, 2005; Weiss, 1979), including: the *conceptual* or *enlightenment* model (where a body of knowledge shapes a broader policy agenda) (eg, Dunlop, 2014; Radaelli, 1995; Weiss, 1979); the *strategic* model (where knowledge is used tactically by different actors in particular sectors and venues of decision making) (Owens, 2005); and the *coproduction* or social model (whereby knowledge use and generation result from a two-way process of interaction between knowledge generators and users) (Haines-Young and Potschin, 2014; McKenzie et al, 2014; Owens, 2012). To these, Dunlop (2014) (quoting Boswell) adds *political* (or what is sometimes termed *symbolic*) use, whereby policy makers are compelled to use certain types of knowledge by some external imperative such as a higher authority. Of course, there is also the possibility of nonuse; but as Dunlop (2014) notes, while this is analytically possible, it is very unlikely, with conscious rejection being the more likely explanation.

A second way to organise the literature involves focusing on the processes that shape 'why' particular forms of knowledge are used in the way that they are. This includes: how power relationships within a policy sector determine what counts as legitimate knowledge and how it is used (eg, Juntti et al, 2009; Radaelli, 1995); the role of scientific actors as policy advocates in a given policy sector; and how the processes of agenda setting within different stages of decision making influence the types of knowledge that decision makers seek out to advance their basic worldviews (Radaelli, 1995; Sabatier, 1998).

A third way of organising the literature entails understanding the different types of knowledge that decision makers can draw on to help formulate policy, ranging from scientific research through to expert advice and lay knowledge. However, not all knowledge is given equal weight by decision makers, with some being seen as more legitimate, salient, or credible than others (Juntti et al, 2009). Moreover, some types and/or framings of knowledge can claim to be more legitimate than others (Rich, 1997)—see below. Some scholars argue that the ways in which knowledge is collected, processed, agreed upon, and presented (or framed) to users can influence whether or not it is used. This way of organising the literature finds a particularly strong expression in the ongoing and still largely unresolved debate over whether economic framings of the environment, together with more economic venues of analysis such as CBA, provide more credible and 'usable' knowledge opportunities to link suppliers and users of knowledge (Haas, 2004, pages 573–574) than those occurring when more scientific framing and/or deliberative and participatory venues dominate (Fish, 2011; Hanley, 2001). However, the aforementioned theories of knowledge utilisation suggest that whether knowledge is seen as legitimate is strongly determined by the processes of collection (ie, covering the first and second organising devices mentioned above) and use (eg, power relations or problem framing around—for instance, environmental values versus ecosystem services), which are in turn related to the specific context or venue of use (Cowell and Lennon, 2014; Nutley et al, 2007). Indeed, while immediate and instrumental utilisation may be limited, the process of interaction between producers and users may nonetheless have significant effects in terms of fostering greater trust, promoting longer term policy learning, and even encouraging the emergence of new problem conceptualisations (Nutley et al, 2007, page 302).

Fourth, the literature can be organised in terms of explanations for why, in certain contexts and venues, "[k]nowledge can speak volumes to power" and in others it is ignored (Haas, 2004, page 587). But what are the critical, enabling factors, and to what extent can they be tweaked to enhance use? Much of the research in this area draws upon Caplan's (1979) two cultures approach, where a distinction is made between knowledge generators and users. Hence improvements to knowledge utilisation are characterised by a metaphor of 'bridging the gap' between the two cultures. While this offers a parsimonious characterisation, it may "camouflage … the complex interactions that produce a … decision" (Rich, 1991, page 325). One line of research that has aimed to provide a richer account is that dealing with 'boundary work'—that is, the boundary between knowledge production and policy (use). It investigates ways in which that boundary is (not) or can be managed through organisations (eg, environment ministries), individuals (eg, policy entrepreneurs), or instituitionalising processes and procedures (eg, the MEA and the NEA), etc (Owens et al, 2006) that seek to affect knowledge utilisation processes. Others such as Nutley et al (2007) and Haas (2004) have focused on more generic factors. For example, Nutley et al (2007) list factors such as: translating the research; establishing ownership; increasing the need for advocates or champions; targeting context-specific barriers to, and enablers of, change; highlighting the importance of knowledge being seen as credible and salient; and the role of strong higher level leadership.

4 Main themes and key findings

4.1 Understanding the past

Rather than specify which of these four perspectives should be applied, we asked the authors of the papers to draw on them selectively to gain relevant insights and thus explore their respective opportunities and blind spots in relation to ecological knowledge use. Together, they confirm that the ecosystem services idea did not emerge in an institutional void. As Cowell and Lennon (2014) point out, it is just the latest in a very long line of attempts to ensure that the 'true value' of the environment is reflected in decision making. The existing literatures on the fate of these attempts suggest that the impact of knowledge use has been patchy at best [see Juntti et al (2009) for an overview]. Using an 'analogue' approach, Cowell and Lennon (2014) confidently predict that advocates of ecosystem services will encounter similar problems. Moreover, Turnpenny et al (2014) observe that recent attempts in the UK to incorporate ecological knowledge into policy-level appraisal mirrors many previous efforts to embed environmental knowledge in appraisal in the UK (Russel and Jordan, 2007) and elsewhere (Adelle et al, 2012). Indeed, Turnpenny et al (2014) observe that the weak integration of ecological knowledge into policy appraisal strongly reflects these historic patterns, and that lessons from the past need to be learnt, however uncomfortable that may be [see Dunlop (2014) on the link between knowledge use and learning]. For instance, in policy-level appraisal, environmental issues (including the ecosystem services framing) have traditionally been crowded out, as 'non'environmental ministries target economic priorities. Knowledge and political power have, as the knowledge utilisation literature suggests (Juntti et al, 2009; Radaelli, 1995), always been very deeply intertwined.

The failure to fully learn lessons from the past can also be found in other policy venues. Hockley (2014), for example, notes that CBA has long been considered 'the best game in town' for embedding environmental knowledge, on account of its clarity and perceived lack of arbitrariness. It was not at all surprising that it was strongly advocated by advocates of ecosystem services (HM Treasury, 2012; TEEB, 2010). But the actual use of environmental knowledge in this venue has generally been 'sporadic' at best (Hockley, 2014). Even in the environmental sector, he argues, CBAs have been used strategically by environmental ministries and agencies to win political battles with 'non'environmental actors, rather than to directly inform and/or improve policy making. This situation suggests naivety on behalf of the environment ministry regarding assumptions that other ministries would use environmental information framed in terms of services in an entirely instrumental fashion. In fact, the environment ministry in the UK has rarely practised CBA in its textbook form (Russel and Jordan, 2007); and in the US—the country which originally pioneered it—CBAs are 'seriously deficient' (Harrington et al, 2009), suggesting a gap between the expert and user communities (Caplan, 1979), as well as between what the environment ministry preaches and what it practises.

Such effects can be exacerbated by the norms, values, and problem framings that different ecosystems assessment techniques have embedded in them. These can greatly influence the venues in which new assessment approaches are adopted, and the use that is derived from them (see Cowell and Lennon, 2014). This situation can be explained in relation to the 'expedience' argument that using economic language is the most direct route to giving the environment greater weight in decision making. However, as the papers in this theme issue clearly demonstrate, this instrumental framing is only one example of how knowledge is actually used (Dunlop, 2014), and a relatively rare one at that. Thus when it comes to embedding ecological knowledge, little thought has been given to other types of knowledge use; many studies more or less implicitly seek—or expect—a highly instrumental form of knowledge utilisation (McKenzie et al, 2014), and when this is not found "a common conclusion is that ESK [ecosystem services knowledge] is not used at all" (page 322).

4.2 The move to ecosystem services: drivers and initial expectations of use

The papers assembled in this theme issue do not seek to offer a definitive explanation for why the shift to thinking about ecosystem services occurred. As indicated above, previous attempts at better embedding environmental factors into decision making had been far from successful, and in many of the papers ecosystem services are presented as the 'next big push' by environmentalists. Clearly, international factors were important in this respect, culminating in the publication of the MEA. The MEA raised the stakes for domestic policy makers leading to the development of national assessments in many countries, with the UK very much in the vanguard (see Waylen and Young, 2014).

What the papers do address more directly are questions around what the focus on ecosystems implies for knowledge utilisation, and to what extent these implications were considered by knowledge producers and/or users. An immediate challenge relates to the epistemic uncertainty surrounding the concept (Dunlop, 2014). As noted above, the linear instrumental view of use has staying power partly because it explains and is appropriate to policy issues where problems and solutions are closely aligned. In contrast, ecosystem (services) knowledge has developed only relatively recently, and there is not yet a settled paradigm. In such a context, knowledge is essentially contestable, which can immediately restrict its tractability in relatively technocratic venues such as CBAs which seek to 'close down' policy formulation discussions and arrive at a particular policy choice (Hockley, 2014). Such a dynamic is only exacerbated by well-known knowledge games and power politics that characterise many venues (Juntti et al, 2009; Radaelli, 1995).

The vexed issue of knowledge utilisation was arguably considered when the NEA was designed. As Waylen and Young (2014) observe, use was implicitly prioritised through the creation of joint chairs, a secretariat, and also a client group, in addition to all chapters undergoing intensive, joint peer reviewing via a form of knowledge coconstruction. Moreover, Dunlop (2014) argues that attempts to develop a common conceptual approach in the NEA were founded on an expectation that they would open up new spaces for local-level interpretation. Indeed, the UK environment ministry has itself tried to directly encourage use through the setting up of demonstrator projects to tailor knowledge to users in particular venues—very usefully reviewed in this issue by Haines-Young and Potschin (2014). But like many knowledge brokering strategies, they have required—to again quote Weiss—much time, significant resources, and a great deal of patience: vital commodities which may not be uniformly available in all situations (Lemos et al, 2012, page 792).

Waylen and Young (2014) argue that the designers of the NEA hoped for instrumental use in the short to medium term. But anyone who has read through the knowledge utilisation literature would probably suggest that this was a highly laudable but somewhat naive expectation (eg, Juntti et al, 2009; Nutley et al, 2007; Owens, 2005). So, although a white paper appeared only days after the publication of the NEA, it quoted rather selectively from its recommendations and pursued many preexisting policy objectives. What could explain the discrepancy between knowledge and policy action? It may be related to the nebulous and flexible nature of the ecosystem services concept (Haines-Young and Potschin, 2014), which is part normative and part rational–instrumental (Cowell and Lennon, 2014). It could also be down to the design of integrated assessments such as the MEA and the NEA, which were paradoxically not, it seems, themselves directly informed by the knowledge utilisation literature (Waylen and Young, 2014)—see above. As regards the NEA, there appears to have been no clear definition ex ante of potential users or uses, again suggesting a gap between expert and user communities (Caplan, 1979). In principle, there were many possible uses, ranging from validation of the MEA through to the identification of specific general policy responses, and users (ie, policy makers, nongovernmental bodies, business, etc) (Waylen and Young, 2014). When the NEA was launched to the media, ecological knowledge was strongly oriented around an instrumental–economic framing of ecosystem services, even though only two out of twenty-seven chapters were primarily devoted to these aspects. This framing was reinforced in the UK's Natural Environment White Paper which placed heavy reliance on impact assessment (Turnpenny et al, 2014) and CBA. Some of these concerns were, however, subsequently picked up in the UK NEA Follow-on project—on which more below.

4.3 The utilisation of ecosystem service knowledge: unfolding experiences

Having discussed the expectations that different actors had in relation to knowledge, what do the papers reveal about how it was actually used in policy venues? Most of them identify all four types of knowledge use as categorised by Weiss (1979). As noted above, Waylen and Young (2014) report that, at the broad level of the NEA, the instrumental use made of the assessment knowledge could be assessed in the immediate publication of a white paper on the natural environment. As is well known, white papers seek to gather opinion on a general direction of policy, not discuss a specific law or policy. Ultimately, therefore, Waylen and Young conclude that it is too soon to measure how the NEA has been used, especially in terms of the adoption of new ways of thinking associated with more conceptual forms of use.

In the venue of land-use planning, Cowell and Lennon (2014) argue that there is a need to carefully account for the interaction between internal (ie, knowledge quality factors) and external (ie, institutions, venues, etc) factors. Moreover, they observe that while there is, to date, little empirical evidence of the extent of use in this venue (however, see Russel et al, 2014), through examining earlier experiences with related ideas, some expectations can nonetheless be formulated. Where knowledge on ecosystem services is more likely to stick is in areas and regions which are already dependent on (or attached to) environmental quality, suggesting that a strongly strategic type of use may eventually predominate. Moreover, Cowell and Lennon (2014) observe that wide stakeholder buy-in is likely to be a necessary but insufficient condition for ecological knowledge use; a combination of institutional settings, local capacities, and local entrepreneurs and intermediaries will also be vital. Even then, embedding is likely to struggle to survive what they term obligatory passage points in the planning system (eg, planning inquiries), where proeconomic growth arguments tend to quickly reassert themselves.

Turnpenny et al (2014) examine a large sample of policy-level appraisals and find that there is a great deal of apparent nonuse of ecological knowledge in this venue, with very few explicitly engaging with the ecosystem services concept. Like Dunlop (2014), they acknowledge that in some cases this may not be so much nonuse but a form of symbolic and/or political use. And where instrumental–conceptual use can be observed, they find that more traditional types of ecological knowledge are just as likely to be used [ie, those associated with regulating services (eg, flood protection, climate regulation)] than the more nebulous categories like cultural services. While microlevel capacity issues are flagged (eg, lack of time, expertise, and finance) at the level of individual appraisers, they caution against overindividualising knowledge use (Nutley et al, 2007, page 307). Rather, they claim that strong and enduring differences between ministries suggest the presence of mesolevel institutional dynamics linked to processes of cross-governmental bargaining and/or regulatory games, in the vein of strategic knowledge use. However, using the example of the United States, Hockley (2014) explains that, although CBAs may not have a significant effect on regulatory outputs in the short term, they may have a more diffuse conceptual-enlightenment effect over longer periods of time.

Haines-Young and Potschin (2014) also find little evidence to support the rational–linear model of instrumental knowledge use. But at the more local level they do find knowledge being iteratively coproduced by producers and users. As new knowledge was generated, the contexts in which the projects operated also changed, with debates evolving and, in some instances, reducing conflicts. Where more instrumental types of use occurred, they required some type of conceptual enlightenment through coproduction between scientists and other stakeholders.

Similar processes are reported by McKenzie et al (2014) in their careful evaluation of planning processes in Central and North America. They also find that knowledge is used in multiple and diverse ways. Initially, conceptual use was more prevalent when knowledge producers sought to engage stakeholders, whereas later on more instrumental forms were used to directly shape the decision-making process. Contrary to expectations, strategic use was not necessarily negative; it also entailed empowering less powerful indigenous groups, through processes of coproduction. In short, like much of the existing literature, instrumental use was only one way in which ecological knowledge was deployed in different venues.

4.4 Ecological knowledge utilisation: future directions for research and policy

The question of if and how ecological knowledge can be more fully embedded into decision making is massively underresearched. The papers in this theme issue have highlighted many important areas for future research (see also Fazey et al, 2012). For researchers, the papers confirm that knowledge utilisation is a complex and subtle subject. Causality is difficult to pin down, and longer time frames are often needed to fully comprehend the more diffuse effects of new knowledge (McKenzie et al, 2014), particularly for conceptual uses which by their nature tend to extend over long periods of time (Owens, 2012). As McKenzie et al (2014) note, our limited understanding of how ecological knowledge is used constrains our ability to learn from, replicate, and convey success stories. Moreover, moving beyond the concept of use to actually demonstrating *impact* is very difficult because of the number of interacting variables (Turnpenny et al, 2014). In fact, users may themselves unwittingly compound the 'problem of little effect' by refusing to reveal sources, especially in relation to the more symbolic and political categories of use (McKenzie et al, 2014).

Most of the papers also highlight the need for more empirical studies deploying mixed methods, including documentary analysis, focus groups, citation studies, interviews, ethnography, and even quasi-experimental approaches (Cowell and Lennon, 2014; McKenzie et al, 2014; Turnpenny et al, 2014; Waylen and Young, 2014). New research could—among other things—examine: the constraints faced by potential users in engaging in coproduction on the ground

(Dunlop, 2014); variations in knowledge use over time (Dunlop, 2014; Turnpenny et al, 2014); the scope for moving beyond typologies and a priori definitions of knowledge, to assess what motivates choices or tactics in particular policy situations (Haines-Young and Potschin, 2014; Waylen and Young, 2014); whether or not it is possible to derive broader lessons by employing larger '*n*' studies and controlled comparisons (Haines-Young and Potschin, 2014); and more rigorous evaluations of the actual impacts of knowledge on policy outcomes (McKenzie et al, 2014). There is also plenty of scope for exploring different ways to enhance use, whether that be in terms of the supply of knowledge (for example, teasing out the effect of different framings, such as cultural or economic services provided), the demand for it among users, or exchange and/or brokering strategies that mediate between the two communities (Lemos et al, 2012, pages 790–792; Nutley et al, 2007, pages 310–312; Russel et al, 2014; Ward et al, 2009).

At the same time, the papers also argue for more theoretical–conceptual work, which may include: developing understandings of ecological knowledge use that are more sensitive to the issues of power and control (Cowell and Lennon, 2014; McKenzie et al, 2014; Waylen and Young, 2014); combining perspectives from the knowledge utilisation and public participation literatures to better conceptualise processes of coproduction (McKenzie et al, 2014); and providing better theoretical explanations of how the types of knowledge utilisation in Weiss's original typology interact and interweave (Dunlop, 2014).

For policy makers the existing literature identifies numerous ways in which knowledge utilisation can(not) be enhanced. Like much of the existing literature (outlined in section 3), the seven papers confirm the complex, varied, and contingent nature of much knowledge use. In short, there are many knowledges and many possible users and uses, and therefore many potential enabling strategies. To draw more meaningful policy lessons, Dunlop (2014) argues that we should think in terms of processes rather than linear models, with a focus on learning about the dynamic nature of utilisation, involving claims, counterclaims, argumentation, and denial. Haines-Young and Potschin (2014) argue that the messiness of knowledge use in decision making may be better understood if one acknowledges that the process involves both use and generation, with the exact relationship between the two changing over the time of the policy activity as external influences are calibrated, refined, and applied to specific settings (cf Caplan, 1979).

Improving the uptake of ecological knowledge may well depend on 'policy entrepreneurs' or 'skilled intermediaries' who are both articulate and eloquent specialists and fully aware of the precise policy context in which they are operating (Pielke, 2007; Russel et al, 2014), and willing to match their role accordingly (Cowell and Lennon, 2014; Weible et al, 2011). Given what we know about the various ways in which knowledge can be used in the policy process, we need a clearer understanding of the boundaries of the possible, especially around the skills that advocates of ecosystem services should ideally have (Dunlop, 2014). Such skills include having the ability to exploit opportunity structures (Cowell and Lennon, 2014; Russel et al, 2014) or utilise the 'persuasive' power of reports like the NEA to 'open doors' for new collaborations and partnerships (Waylen and Young, 2014). According to Dunlop (2014), the answer is context specific (also see Nutley et al, 2007, page 303) and very much dependent on the level of governance and also the sector (for example, enhancing knowledge use at more local levels requires an ability to engage hearts as well as minds). Also, much depends on what type of learning is expected or sought: for example, for epistemic learning, political antenna and epistemic humility are needed; for bargaining, a willingness to advocate policy positions is needed. Regardless of context and type of learning sought, there is a real danger that if imposed, technical knowledge could stifle local-level innovations in use (Dunlop, 2014). Indeed, Cowell and Lennon (2014) observe that foisting particular knowledge integration methodologies on intermediaries and users can trigger negative reactions that may eventually lead to nonuse.

What lessons can be drawn for other policy sectors and problem areas? For users, a ‘new’ concept such as ecosystem services may be only ‘the latest candidate’ in a long-running story (Cowell and Lennon, 2014; Turnpenny et al, 2014). Perhaps constant methodological and conceptual refinement by environmentalists is a sign of weakness (Cowell and Lennon, 2014), indicating that not a lot of learning among ‘non’environmental actors has occurred in the past. Thus, better up-front thinking about users, uses (Waylen and Young, 2014), upstream engagement, and production (Dunlop, 2014) is arguably needed to significantly enhance future use. In this sense public participation is a potentially important enabler of conceptual enlightenment across stakeholder groups. Tools such as CBA could be used by multiple stakeholders to explore different ways of implementing the concept of ecosystem services, rather than as a technocratic tool to impose an answer (Hockley, 2014). Moreover, stakeholder involvement may enhance a policy’s chances of surviving the early stages of consultation, cross-examination, and formal approval, so as to enhance the legitimacy of knowledge (Cowell and Lennon, 2014). Building on indigenous knowledge may be also important in such processes (McKenzie et al, 2014). But on a more cautionary note, policy deliberation can also slow down the production of policy outcomes as it is a slow and resource-intensive process (Dunlop, 2014), producing reluctance amongst policy makers to engage.

Having claimed that the UK represents a ‘more likely’ case in the uptake of ecological knowledge, it is useful to note that the patterns of ecological knowledge use across the venues suggest that in some cases it is limited (eg, UK planning and policy appraisal), while in others it is more widespread (eg, at the local level). This finding, coupled with multiple types of use highlighted by McKenzie et al (2014) in the international cases, suggests that, even with countries in the vanguard of embedding the concept of ecosystem services, knowledge utilisation is a tricky problem. In many respects, the findings from the papers chime strongly with messages emerging from the UK NEA Follow-on, which had the issue of use as a key focus (NEAFO, 2014). Indeed, noninstrumental uses and processes can have positive impacts on decisions around the management of ecosystems, facilitating communication between stakeholders to better anticipate and mediate potential conflicts. The challenge is how to ensure that these deliver benefits to a sufficient number of those involved to ensure the whole endeavour is *politically* sustainable. Politicians are often under intense pressure to deliver policy outputs and outcomes as quickly and as efficiently as possible, even more so in times of economic austerity. But focusing exclusively on instrumental uses can, as noted above, easily lead to frustration and eventually disillusionment in the policy process, including, crucially, those elements such as the NEA that were created with the explicit aim of building knowledge use. However, waiting for conceptual uses and learning, and building the necessary alliances of stakeholders, can be very time-consuming, meaning that many ecosystem services may have already been damaged by the time knowledge feeds through into action. Finding some way out of this potential chicken-and-egg problem arguably constitutes one of the most tricky problems of all in the governance of ecological knowledge.

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