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Editorial: Assessing and valuing peatland ecosystem services for sustainable management

Reed MS, Bonn A, Evans C, Glenk K, Hansjürgens B

Introduction

The Millennium Ecosystem Assessment (2005) identified significant market failures linked to the supply of ecosystem services which have led to degradation of ecosystems around the world, with the deterioration of both stocks of natural capital and flows of services at an alarming scale. Broadly speaking, two types of approach have been taken to tackle these challenges: market-based and regulatory approaches. An increasing number of Payment for Ecosystem Service schemes have arisen around the world, for example where downstream users of water pay for catchment management upstream, that can sustain the required supply and quality of water (e.g. Wunder et al., 2008; Fisher et al., 2010). At the same time, regulatory approaches have also proliferated, such the EU's Water Framework Directive, which aims to protect and enhance the provision of water-related ecosystem services. Both market-based and regulatory approaches require the quantification (and ideally valuation) of ecosystem service benefits, to justify and spatially target the high levels of investment that are often required.

However, there are significant gaps in our understanding of links between the management, function and flows of ecosystem services, and how different groups of beneficiaries value these stocks and flows in complex and uncertain socio-ecological systems. Understanding the values that are placed on these services is crucial for selecting and designing effective policy instruments that can sustain the future provision of services that underpin human well-being. However, it is a major challenge to adapt these policy instruments to the range of overlapping scales at which different ecosystem functions operate and can be manipulated to influence the provision of ecosystem services.

This special section therefore explores how issues of complexity, uncertainty and scale may be incorporated in decision-making for the natural environment. Trade-offs are inevitable between the accuracy and the simplicity of the approach that is used to value ecosystem services. However, the articles explore a range of broad approaches and specific methods that may have the capacity to provide decision-makers with simple, yet reliable evidence about links between policy options, land management and other pressures, ecosystem functions, and the consequent value of stocks and flows of final ecosystem services. In addition to monetary techniques for valuing ecosystem services, the articles consider how monetary valuation may be integrated with participatory and deliberative techniques to provide decision-makers with more nuanced and comprehensive information about the values and preferences of different beneficiary groups.

Case study context

Peatlands are an ideal case study in which to ask questions about links between the science and values associated with ecosystem service delivery, given growing evidence linking ecosystem functions, services and markets in peatlands, the plethora of regulation and overlapping protective designations associated with these sites, and the growing number of peatland PES schemes. Each of the articles in this special section therefore uses peatlands as a lens through which to examine questions of international significance. By considering how theory and methods can be operationalized in a specific context, it is possible to identify (and attempt to overcome) more specific challenges that are likely to have greater resonance in other real-world contexts, whilst drawing conclusions that are of direct relevance to local decision-makers.

Peatlands are of particular interest due to their important role in storing carbon and their significance for nature conservation. Given that many peatlands are located in uplands, in many countries peatlands are also important for the provision of clean drinking water and recreational opportunities. However, many peatlands are also used for livestock grazing, sporting interests and peat extraction, and these activities have often compromised habitats, carbon storage and water quality. Nowhere are these pressures more intense than in the UK, where the majority of lowland peat soils have been lost to agriculture or peat extraction, and where the majority of upland peats are managed for livestock and game, in addition to water supply, nature conservation and recreation. Peatlands are the UK's most significant carbon store and form the largest area of semi-natural habitat in the country, hosting a wealth of nationally and internationally important biodiversity and providing amenity value for millions of people. In the UK, the majority of drinking water is derived from surface water that comes predominantly from peaty upland catchments. In the past, an estimated 80% UK peatlands have been damaged or converted to other land uses such as forestry, leading to emission of Greenhouse Gases, loss of biodiversity and water quality reduction. In the face of climate change, healthy peatlands can help society mitigate and adapt to climate change by providing climate and water regulating services. At the same time, a changing climate can impact on the delivery of these services, and peatlands need to be managed to make them resilient to such change.

This requires a full understanding of the stocks of natural capital, the flows of services peatlands provide, and how best to manage these under an uncertain future. By valuing changes in the provision of ecosystem services under future scenarios it may be possible to identify adaptation strategies that can optimise social welfare benefits, and develop regulatory and market-based instruments that can protect and enhance priority services. In many cases, difficult choices will have to be made in future about which ecosystem services to prioritise. The goal of these papers is to identify the tools needed to incorporate the values of different beneficiaries at different spatial scales in that decision-making process, and to ensure that investments are spatially targeted to deliver maximum benefits for social welfare.

Aims

The aims of this special section are to use UK peatlands as a case study to:

1. Identify options for valuing changes to stocks and flows of multiple ecosystem services in complex socio-ecological systems using a combination of monetary and non-monetary approaches:
    a. Reviewing scientific evidence for the effects of peatland management on processes that control delivery of ecosystem goods and services, considering the spatial distribution of ecosystem services in relation to management pressures & beneficiaries and potential trade-offs between provisioning, regulating, supporting and cultural services (Evans et al., this issue)
    b. Using this information to develop a framework that can help identify where restoration or conservation of peatlands would result in greatest social welfare benefits (Glenk et al., this issue); and more specifically,
    c. Integrating hydrological and economic knowledge to value water services and prioritise sites for peatland restoration (Martin-Ortega et al., this issue)
2. Consider how this information might affect the design of financial mechanisms to lever investment in the provision of climate mitigation and adaptation in peatlands
    a. Reviewing available regulatory and institutional frameworks for peatland PES in the context of agri-environment schemes, and considering how such schemes could minimise trade-offs between ecosystem services at a range of scales (Reed et al., this issue)
    b. Developing a roadmap for a regulatory framework that could facilitate a regional carbon market for UK peatlands (Bonn et al., this issue)

The papers

The goal of Evans et al. (this issue) was not to attempt a comprehensive ecosystem service assessment, but rather to quantitatively define a specific set of ecosystem responses to anthropogenic pressures on blanket bogs (specifically drainage, burning and atmospheric deposition of S and N compounds). This was done following a methodology that has the potential for wider application to this and other ecosystem types, based on available data. The approach was intended underpin the robust valuation of costs and benefits associated with policy and land-management decisions. In this way, it may be possible to support the evaluation of co-benefits and trade-offs associated with such decisions, and enable policies to maximise net ecosystem service benefits and social welfare gains. By moving beyond a conceptual approach, and the initial, relatively coarse valuation of ecosystem services carried out within overview studies such as the National Ecosystem Assessment, Evans et al. (this issue) provide insights into the methodological challenges, data requirements, pitfalls and possibilities of integrating scientific, process-based understanding in the assessment and valuation of ecosystem service.

To do this, Evans et al. (this issue) populated a set of “pressure-response functions” for key regulating services associated with blanket bogs. These are analogous to the dose-response functions used in other fields such as toxicology, and which provide a relatively simple, flexible and empirically-based method for defining the pathway through which pressures influence ecosystem functions and services. The approach aims to derive quantitative relationships between anthropogenic pressures (or relevant proxies) and measurable ecosystem functions (e.g. net carbon balance) that can be used as an input for ecosystem service valuation. This scientific underpinning represents a vital first stage in any ecosystem valuation, and without it the valuations obtained (and subsequent decision-making) risk being incomplete, and at worst inaccurate and misleading. By linking this assessment directly to the economic valuation of ecosystem services (Glenk et al., this issue) and the subsequent design of agri-environment schemes (Reed et al., this issue) in the same case study ecosystem, the special section considers how valuation studies can draw more effectively upon biophysical evidence, how such evidence could be constructed to more effectively inform valuation, and how valuation evidence can inform the governance of ecosystem services.

However, even with adequate data about the relationships between pressures, ecosystem functions and ecosystem services, Glenk et al (this issue) identify a number of challenges to valuing ecosystem services in real-world, complex socio-ecological systems. For example, biophysical modelling of restoration impacts is highly complex, given the need to capture non-linear relationships and interactive effects, and this makes it difficult to assess where, when and how costs and benefits of policy options are generated for beneficiaries. Although it may sacrifice some of the nuances of modeling approaches, the “pressure-response function” approach proposed by Evans et al. (this issue) provides a simple and transparent method for the quantitative analysis of the full impact pathway from anthropogenic pressure to economic outcome, based on realistically available data. Future development of the response function approach should be able to take account more effectively of interactions between drivers, scale issues, non-linearities, time lags and potential hysteresis in the relationships between pressures and ecosystem responses.

Little is known about the social welfare impacts of peatland restoration and in particular how to target restoration activities across the country to maximise net benefits from investments in restoration. Glenk et al. (this issue) therefore discuss the steps required to conduct a spatially explicit economic impact assessment of peatland restoration. The first step that they propose is to define boundaries of analysis (including time-frame and spatial scale) and identify restoration scenarios (e.g. techniques and sites). There are a number of challenges to assess how changes in peatlands (e.g. external changes such as climate change and management changes as a result of policy drivers) affect service provision over space and time. For example, the spatial scale of analysis should relate to the scale at which benefits are enjoyed, and this will differ between services. Although it is relatively straight-forward to analyse costs and benefits of changes in ecosystem service provision per unit area, it is difficult to consider connectivity and interdependence of effects between adjacent spatial units. Changes in service provision in one spatial unit cannot be valued in isolation from adjacent or otherwise connected peatland areas. The temporal scale of analysis has a number of effects on valuation. For example, uncertainty increases with longer time-frames (e.g. as opportunity costs vary with commodity prices), but many of the benefits of restoration accrue over long periods. At these time-scales, discounting may negate long term economic benefits of restoration as individuals value short term costs and benefits higher than long-term costs and benefits. In the case of peatland restoration, the costs of restoration are high in the short term, and many of the benefits (e.g. carbon storage) only accrue over the long-term.

Glenk et al. (this issue) go on to review economic methods for assessing the costs and benefits of providing different services, and discuss the role of sensitivity analyses for assessing the impacts of changing assumptions and the effects of risk and uncertainty. Finally, they discuss ways of providing a spatially explicit estimation of social welfare benefits, identifying winners and losers, and consider how this may be used to inform decision-making, for example evaluating different restoration techniques and sites, and engaging with stakeholders to identify compensation mechanisms for losers.

Martin-Ortega et al. (this issue) build on this analysis, to integrate biophysical and economic knowledge about peatland restoration to identify challenges for valuing water related benefits in policy-making, with a particular focus on the Water Framework Directive. They review evidence for the provision of water-based services from peatlands, and the biophysical effects of degradation and restoration. They then identify challenges for monetary valuation of the water service benefits of peatland restoration for water utilities and wider society. Challenges include: the need to base valuation on final ecosystem services (e.g. sediment loads), despite the fact that much of the current evidence is for effects of restoration on intermediate processes (e.g. salmonid populations); time-lags for some of the benefits of restoration, which may reduce the value placed on those benefits; communicating complex science in valuation scenarios that members of the public can understand; accounting for the spatial distribution of benefits and beneficiaries (mainly downstream from peatland catchments); and limited availability of commercially sensitive data from water utilities. The article concludes by discussing ways of overcoming these challenges, for example developing water quality "ladders" to communicate water quality change scenarios to members of the public, and the use of benefit transfer methods to so that values derived from other ecosystems could be used in the absence of water quality and cost data from peatlands. However, many of these options present decision-makers with a trade-off between data quality and accuracy versus access to cost-effective and rapid information for decision-making.

The last two papers in this special issue apply insights from the first three papers to enhance or develop financial mechanisms to pay for the provision of ecosystem services from peatlands. Reed et al. (this issue) considers how land management contracts funded via the pillar 2 of the EU's Common Agriculture Policy could be improved to derive a higher return of ecosystem services from agricultural land, through deliberation with members of the public, land owners, managers and other stakeholders. They propose an approach that aims to: i) pay more for the ecosystem services that are valued most by society; ii) spatially target payments to the locations where ecosystem services can most efficiently be provided; and iii) provide incentives for cross-boundary collaboration over the provision of ecosystem services that need to be managed at catchment or wider spatial scales. Using upland peatlands as a case study, and drawing on experience tackling these issues in the new Glastir agri-environment scheme in Wales, the paper attempts to find a balance between current input-based schemes that pay for land management activities and output-based schemes that pay by results.

Finally, Bonn et al. (this issue) consider how payments for ecosystem services could facilitate peatland restoration through payments for climate regulation, bundled or layered with payments for co-benefits such as water quality and biodiversity. They start by reviewing the evidence for the climate benefits of peatland restoration. They then argue that to achieve peatland restoration at the scales that are being called for by conservationists, new market-based instruments alongside public funding are needed. However, to provide investors with sufficient confidence that climate benefits will accrue without leading to trade-offs with other ecosystem services, a system is needed to provide standards, verification and accreditation, combined with a cost-effective methodology for verifying emissions reductions under different peatland management and restoration regimes. Bonn et al. (this issue) therefore outline a road map towards a peatland carbon code for the UK, which could underpin a regional carbon market to pay for peatland restoration. This would help the UK meet its Kyoto and domestic policy targets, whilst providing investors with the option to trade this carbon on voluntary markets in future. The paper outlines the steps that would need to be taken to create a code that would provide investors with confidence that emission reductions are fully verified, transparent, additional and permanent. While peatland restoration projects may be marketed primarily on the basis of carbon and hence climate regulation, there must be safeguards to prevent trade-offs with other important ecosystem services. Standards and technical guidance within the proposed code could also consider how co-benefits, such as watershed protection, conservation of biodiversity and social goals, can be attained and potentially monetised, to help meet the costs of restoring more heavily degraded or remote sites.

Biodiversity fits uncomfortably in many of the papers in this special section. Biodiversity or its constituent components has been recognised to have a critical influence on the ecosystem functions that determine ecosystem service flows (Cardinale et al., 2012; de Bello et al., 2010). However, as for many habitats, the role that biodiversity may play in mediating the provision of ecosystem services in peatlands is poorly understood. There is also little known about the dimensions of biodiversity that different social groups value most, and how best to value biodiversity within ecosystem service valuations. Glenk et al. (this issue) suggest a “no regrets” approach to decision-making around biodiversity to avoid trade-offs with other ecosystem services, where decisions are only taken that would not compromise biodiversity conservation objectives. However they recognise that given the highly anthropocentric nature of the ecosystem services framework, such a value judgement may not always be socially or politically acceptable.

Conclusion

This special section uses UK peatlands as a lens through which to examine how policy instruments designed to facilitate restoration of degraded land might affect ecosystem function and consequently determine changes in the stocks of natural capital and flows of ecosystem services from the land. This is used as the basis for developing methods to spatially assess how different groups of beneficiaries are likely value these stocks and flows in complex and uncertain socio-ecological systems. Challenges are discussed, for example relating to the many overlapping spatial scales at which ecosystem functions and services operate and the spatial dependence of changes in ecosystem services on adjacent or connected spatial units. Challenges are also discussed in relation to the temporal scales at which many ecosystems require management, which may place an emphasis on short-term costs, while reducing the value placed upon longer-term benefits. These values may be further undermined by increasing uncertainty over long time horizons, for example relating to opportunity costs, which may be very different in a long-term future where climate-induced food shortages lead to increases in commodity prices.

Understanding the values that are placed upon these services is crucial for selecting and designing effective policy instruments that can sustain the future provision of services that underpin human well-being. However, these policy instruments need to be adapted to incorporate the values of different beneficiary groups at different spatial scales. The papers discuss a range of monetary techniques that may help overcome many of the challenges identified, but they also recognise the importance of eliciting and deliberating over values through participation with the widest possible range of stakeholders. Only in this way may it be possible to incorporate values in decision-making that are as well informed as possible by the available evidence, and that have the capacity to go beyond monetary values when necessary.