Environmental Impact Assessment Review 72 (2018) 157–165

Contents lists available at ScienceDirect

Environmental Impact Assessment Review

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

The ecosystem approach in ecological impact assessment: Lessons learned from windfarm developments on peatlands in Scotland

Joanna Wawrzyczek[a], Richard Lindsay[b], Marc J. Metzger[a], Fabien Quétier[c,*]

[a] School of GeoSciences, The University of Edinburgh, Drummond Street, Edinburgh EH8 9XP, Scotland, UK
[b] Sustainability Research Institute, University of East London, University Way, E16 2RD London, UK
[c] Biotope, 22 Boulevard Maréchal Foch, F-34140, Mèze BP 58, France

ARTICLE INFO

Keywords:
Windfarm
Environmental Impact Assessment
Ecosystem services

ABSTRACT

The Ecosystem Approach introduced in 1994 through the Convention on Biological Diversity, together with related Ecosystem-based Management and Landscape Approaches, are frequently called upon to improve ecological impact assessment. Current practice typically does not have such a systems focus and we explore the potential for explicitly adopting an Ecosystem Approach in the Environmental Impact Assessment process using wind energy development on peatland, in Scotland, as a case study. Based on a review of 21 windfarm projects (> 50 MW) approved by the Scottish Government we provide an overview of current practice and identify and discuss how the 12 principles of the Ecosystem Approach can help identify options for more appropriate impact assessment. These include defining functional units of analysis that reflect the spatial and temporal linkages of peatland elements through hydrological connections, rather than a focus on individual vegetation types and simple distance buffers. Our conclusions are not limited to peatland and are relevant wherever meaningful functional management units can be defined, including in marine environments. Our results also show that environmental statements for wind energy development in Scotland largely ignore ecosystem services and the people that benefit from them. As for threatened species and other biodiversity features, an Ecosystem Approach is a prerequisite to the meaningful inclusion of ecosystem services in impact assessment.

1. Introduction

Ecological Impact Assessment (EcIA) plays a crucial role in informing decisions on projects with likely impacts on biodiversity and ecosystems, despite its known limitations (Mandelik et al., 2005). Depending on jurisdictions, the focus is often on species presence or habitat quality (Ashworth et al., 2008). Yet there is now a broad consensus that biodiversity goals are best achieved by methods and concepts targeting populations or communities of interacting species, within their ecological systems (Andrello et al., 2018; Bradshaw et al., 2014; Malhi et al., 2014; Simberloff, 1998; Bowen, 1999; Waylen et al., 2014). Furthermore, social impacts are increasingly considered through the ecosystem service framework (Lamarque et al., 2011; Ban et al., 2013; Jacob et al., 2016). This emerging focus on ecosystems is not reflected in current EcIA practice. We explore here the potential for explicitly adopting an Ecosystem Approach in the Environmental Impact Assessment (EIA) process using onshore wind development in Scotland as a case study, a renewable energy technology with much-debated sustainability credentials (Warren and Birnie, 2009; Lindsay 2018a).

The Ecosystem Approach (EA) is “a strategy for the integrated management of land, water and living resources that promotes conservation and sustainable use in an equitable way” that was introduced in 1994 by the Convention on Biological Diversity (CBD; CBD, 2004). Table 1 lists the twelve Ecosystem Approach Principles, and illustrates how EcIA could benefit from this strategic and integrated approach. There is overlap with more loosely defined “ecosystem-based management” (e.g. Grumbine, 1994; Brunner and Clark, 1997; Lackey, 1998; Slocombe, 1998; Curtin and Prellezo, 2010) and the “landscape approach” (e.g. Franklin, 1993; Lindenmayer et al., 2008; Sayer et al., 2013). As the primary framework for action under the CBD, our analysis is based on those 12 EA principles.

2. Case-study: windfarms in peatland systems

In Scotland, most windfarms are sited within blanket mire landscapes, partly because the landform and wind characteristics of these landscapes are favorable, but also because such areas are generally less economically productive and located away from human settlements.

Peatlands are complex ecosystems built up of an interconnected

---

* Corresponding author.
E-mail address: fquetier@biotope.fr (F. Quétier).

https://doi.org/10.1016/j.eiar.2018.05.011
Received 9 October 2017; Received in revised form 11 March 2018; Accepted 22 May 2018

Table 1
The twelve Ecosystem Approach Principles (CBD, 2004) and their relevance to EIA.

	Ecosystem Approach Principles	Relevance to EIA
1	The objectives of management of land, water and living resources are a matter of societal choices.	EIA aim to ensure that the public are given early and effective opportunities to participate in decision making procedures, e.g. through consultations and hearings.
2	Management should be decentralized to the lowest appropriate level.	EIA are a mechanism for decentralized decision-making, often used by local planning/permitting authorities.
3	Ecosystem managers should consider the effects (actual or potential) of their activities on adjacent and other ecosystems.	EIA aim to inform decision-makers of the likely significant effects of their decision, and this includes effects on adjacent or distant habitats and species.
4	Recognizing potential gains from management, there is usually a need to understand and manage the ecosystem in an economic context.	Actual or potential uses of habitats, or values associated with them, are important considerations in EIA (including baselines and mitigation options). In some instances, such as in applying IFC PS6, the concept of ecosystem services is used to assess these uses and values and take them into account in decision-making.
5	Conservation of ecosystem structure and functioning, in order to maintain ecosystem services, should be a priority target of the ecosystem approach.	
6	Ecosystems must be managed within the limits of their functioning.	EIAs should identify whether ecosystem functioning is significantly affected.
7	The Ecosystem Approach should be undertaken at the appropriate spatial and temporal scale.	Good EIA practice requires a multi-scale approach where different issues are assessed at their appropriate spatial and temporal scale.
8	Recognizing the varying temporal scales and lag-effect that characterize ecosystem processes, objectives for ecosystem management should be set for the long term.	EIA are forward-looking, and can take a long-term perspective if relevant to the project being assessed
9	Management must recognize that change is inevitable.	EIA recognize that developments will have some level of impact and expects the developer to put in place mitigation and restoration plans. Equally, the EcIA should predict how the site would change in case the development does not go ahead.
10	The Ecosystem Approach should seek the appropriate balance between, and integration of, conservation and use of biological diversity.	EcIA aim to inform decisions about balancing conservation of biological diversity and projects with likely significant and negative effects on biological diversity. As such, EcIA should be limited in scope to those aspects of the environment that are of conservation value and are likely to be significantly affected.
11	The Ecosystem Approach should consider all forms of relevant information, including scientific and indigenous and local knowledge, innovations and practices.	The scoping stage of EIA seeks information and advice from statutory and non-statutory organisations and carries out research of relevant literature, e.g. the likely spatial and temporal limits of ecological impacts for specific activities should be justified, where available, by professionally accredited or published scientific studies. Developers should use previous examples of good practice while assessing impacts and designing mitigation and restoration works. Individuals can comment on the proposal.
12	The Ecosystem Approach should involve all relevant sectors of society and scientific disciplines.	EIA aims to ensure that the public are given early and effective opportunities to participate in decision making procedures, e.g. through consultations and hearings. Relevant organisations, including statutory consultees are consulted during scoping process.

mosaic of individual units with characteristic morphology and topography (Ivanov, 1981; Lindsay et al., 1988). SNH (2003) provide a detailed description of Scottish peatlands and their associated flora and fauna. In active peatlands, these units are hydrologically linked and naturally stabilized by physical and hydrological linkages (Minayeva et al., 2016). However, if one or more components of the complex are hydrologically disrupted, the stability can be lost, and, by a domino effect, hydrological alterations can spread far from the initial impact (Lindsay and Bragg, 2005). Peatlands are therefore ideally suited to applying the EA.

Blanket mire peatlands provide many important ecosystem services (JNCC, 2011; Bonn et al., 2009). For example, while known peatlands cover only about 3% of Earth's surface, they contain at least 25% of all carbon stored in soils worldwide (Joosten and Clarke, 2002). Peatlands also play an important role in water purification (Martin-Ortega et al., 2014) and provide important cultural services by underpinning the landscape character of the Scottish Highlands (Whitfield et al., 2011). Scotland has 17,720 km^2 of peat bog (Lindsay and Clough, 2017) − 78% of the UK resource. However, most peatland in the UK is either degrading or recovering with little remaining in a 'near pristine' state (JNCC, 2011).

Three types of peatlands are found in Scotland: blanket bog, raised bog and fens. Only active raised and blanket bogs receive priority European protection under Annex 1 of the EU Habitats Directive (Council Directive 92/43/EEC; EC, 1992). In the lowlands, raised bogs occur as domed mounds of peat and are often isolated features within the landscape, whereas in highly oceanic areas, such as the north and west of Britain, peat tends to develop across entire landscapes, such blanket mire cloaking all but the steepest slopes in a mantle of peat ranging in depth from 30 cm to several metres. The blanket mire landscape is thus an interconnected mosaic of peat-forming systems which function together in a nested, hierarchical way. The overall hierarchy is termed the 'Tope System' (Figs. 1 and 2; Minayeva et al., 2016; Lindsay, 2018b), and includes:

- Macrotopes, ranging from < 100 ha to large landscape units extending for $> 10{,}000$ ha;
- Mesotopes, individual mire units e.g. raised bog;
- Microtopes characterised by distinctive surface morphology (e.g. rounded pools, or linear ridges and hollows), representing a set of vegetation and hydrological conditions;
- Nanotopes which are small-scale structures such as hummocks, pools or ridges (Joosten and Clarke, 2002; Lindsay, 2010).

Although not immediately evident, there is a tight functional relationship between the small-scale nanotope structures and the functioning of a whole mesotope or even macrotope. The small-scale surface architecture of alternating drier 'hummock' nanotopes and wetter 'hollow' nanotopes plays a crucial feedback role in sustaining peat-forming conditions. During dry climate phases, the hummock nanotopes expand, thereby slowing surface-water losses from the bog, whereas in wetter climate phases the hollow nanotopes expand to provide greater capacity for water storage and surface run-off (Barber, 1981). Drainage induces many of the same responses as a shift towards a drier climate (Lindsay et al., 2014a). Drainage also results in substantial long-term subsidence, altering surface gradients and thus inducing yet further drying and subsidence (van der Schaaf, 2000; Lindsay et al., 2014b). The Tope System provides a means of identifying an ecosystem response to an ecosystem impact using smaller scale elements within the hierarchy as signals of change.

The effects that windfarms have on peatland ecosystems can be difficult to observe in a lifetime of a development, but there is already a