Funding for peatland restoration and management

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December 2018

This review was commissioned by the IUCN UK Peatland Programme's Commission of Inquiry on Peatlands. The IUCN UK Peatland Programme is not responsible for the content of this review and does not necessarily endorse the views contained within.

[1] With thanks to Malcolm Ausden, Clifton Bain, Adam Dutton, Klaus Glenk, Julia Martin-Ortega and Nick Mawdsley for constructive comments on an earlier draft. Remaining errors and omissions lie with the authors.

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This report to the IUCN Peatland's Commission of Inquiry updates and extends the previous review by Keenleyside & Moxey (2011) of funding opportunities for peatland restoration and management across the UK. Reflecting the bulk of current restoration activities, the focus is primarily on upland sites under extensive grazing or sporting land uses rather than arable or forestry land use.

The first section briefly reviews ecosystem services associated with peatlands, outlining the benefits of restoration and offering some indicative economic valuations of these. The second section identifies the types and likely magnitude of costs arising from restoration activities, before comparing the relative values of costs and benefits over time to illustrate the merits of restoration. Sections three and four summarise the type and levels of public and private funding for restoration. Section five offers some summary conclusions, highlighting information gaps and areas for further research. Annex A summarises opportunity cost issues, including financial impacts, affecting land managers, together with some mini case-studies.

Ecosystem service benefits

Types of service benefits

Ecosystem Services are defined as the direct and indirect benefits people obtain from ecosystems and are usually sub-divided into four sub-categories: provisioning (e.g. timber), regulating (e.g. water flow), supporting (e.g. nutrient cycling), and cultural (e.g. recreation). The balance between different services delivered from a given location depends partly on an area's natural characteristics, including its quality, and also upon how human activities influence ecosystems.[2] Although some, mainly provisioning, services are experienced and valued through markets, many are not and instead take the form of externalities and public goods (Millennium Ecosystem Assessment, 2005; see Annex B for a description of public goods)

In the case of peatlands, management activities have traditionally focused on provisioning services that generate financial revenues. For example, growing crops, rearing livestock and fuel extraction. Yet functioning peatlands offer a wider range of ecosystem services. For example, in particular, peatlands represent a significant store of carbon and can play a role in mitigating climate change, whilst their ability to store water can play a role in regulating both peak flows during flooding and base flows during dry spells. They also represent important habitats underpinning biodiversity and offer cultural benefits through, for example, recreational opportunities, landscape aesthetics and preservation of archaeological artefacts (Eftec, 2009; Bonn et al., 2016).

Unfortunately, commodity production as a provisioning service has often been associated with management practices that reduce the level of other valuable ecosystem services which cannot be

[2] Cardinale et al. (2012) assessed 1700 papers to assess the evidence linking biodiversity to provisioning and regulating services. Using both experimental and observational studies, evidence shows that biodiversity influences or strongly correlates with certain provisioning and regulating services.

traded in markets. For example, drainage, burning and extraction all alter the ability of peatlands to store carbon and water, reducing the level of regulating services, and increasing external disbenefits through carbon loss, water discolouration and loss of domestic livestock. Management choices can also significantly alter the habitat composition and appearance of landscapes, affecting aspects of cultural and supporting services.

Peatland restoration seeks to recover lost capacity to deliver a broader range of ecosystem services, to achieve a different balance. However, restoration is not a costless exercise, involving expenditure on capital investment and management activities plus (typically) forgoing some provisioning benefits. Consequently, it is desirable to quantify the trade-offs arising from restoration.

Valuing service benefits

Although some ecosystem service benefits associated with peatlands take the form of marketed commodities (e.g. food), many are intangible (e.g. the existence value of species and landscape aesthetics) and/or derived unconsciously (e.g. climate regulation), and, as noted, many have public goods characteristics which mean their value cannot be captured through markets. Moreover, many ecosystem services involve complex and imperfectly understood relationships, with linkages and interdependencies between locations and over time.

It is generally possible to identify services and to qualitatively approximate whether ecosystem service delivery will increase or decrease with land management change. It is also possible to quantitatively estimate the delivery of some services with varying degrees of accuracy. It is, however, much more of a challenge to value service benefits in monetary terms and harder still to 'capture' these values either though government policy or through payments from beneficiaries. For example, if a landowner is paid for sheep but not for the value of the carbon their land sequesters, they have no incentive, beyond their own environmental stewardship concerns, to deliver such a benefit for others.

A further challenge is that capturing the value of peatland ecosystem services involves decisions about complex and uncertain science and complex considerations regarding the nature of value. Yet, ambiguity and misperceptions are common and communicating complex issues to the general public can be difficult (Byg et al., 2017; Martin-Ortega et al., 2017).

Nevertheless, there is an extensive literature on frameworks for economic valuation of ecosystem services and a number of different economic techniques available to ascertain partial economic value. For market goods, price is often used as a proxy. For non-market goods, there are more subjective, stated preference approaches. These essentially involve asking people what they are willing to pay for an additional benefit or are willing to be compensated by for the loss of an existing benefit. Other, more objective approaches exist, based on observable opportunity costs or benefit proxies. For example, the benefit of using floodplain farmland to moderate flooding or reducing water discolouration at source could be valued by considering the next best alternatives, such as deployment of concrete river defences or water treatment plants.

Although still scarce (Wichtmann et al., 2013), there are now some specific economic valuations relevant to peatland. For example, Eftec (2009), Glenk et al. (2014) and Martin-Ortega et al. (2014). Moreover, information is now becoming available to support estimation of restoration benefits. For example, Glenk & Martin-Ortega (2018) report use of an online survey of 2000 people to value

carbon, water and wildlife benefits arising from restoration activities under the Peatland Action plan in Scotland. Estimated valuations ranged between £127/ha/year and £414/ha/year, depending on the type and location of restoration considered. Further survey work by Glenk et al. (2018) suggests that the public also recognises the merits of not delaying restoration, to avoid additional degradation (but also that public understanding of science is imperfect). Such stated preference type approaches are subjective and arguably more reliable for simple benefits rather than complex ones like carbon or biodiversity, but do illustrate the scope for eliciting partial values for the ecosystem services that are currently unrecompensed.[3]

These figures are similar to results from more generic studies undertaken for other purposes, notably the National Ecosystem Assessment (Bateman et al., 2011) and assessment of the Biodiversity Action Plan (Christie et al., 2011). Harlow et al. (2012) estimated peatland-specific values from these studies of between £152/ha/yr and £411/ha/yr, again depending on the degree of restoration involved. Although care has to be taken in comparing results across studies due to methodical and contextual differences, the similarity in the range of estimated benefits with those of Glenk & Martin-Ortega (2018) is reassuring.

An alternative approach is to focus solely on the value of carbon emissions avoided through restoration, and to value these via non-traded carbon prices published by government explicitly for economic analysis (e.g. see Moxey & Moran, 2014).[4] This gives a lower-bound estimate of restoration benefits, but avoids recourse to survey-based valuation techniques. Applying central carbon prices to emission savings specified in the Peatland Code suggests carbon benefits of up to £1350/ha/yr for restoring actively eroding sites or between £90/ha/yr and £210/ha/yr for restoring moderately degraded sites more typical of those specified in survey valuations. The Natural Capital Committee (2015) used this approach to derive an aggregate value of £570m for restoring 140k ha of upland peatland.

Although the various estimates are broadly consistent, they do still exhibit some variation. This reflects differences in methodologies but also the specific services, contexts and scenarios considered. Moreover, estimated future benefits can be highly sensitive to assumptions about environmental conditions (e.g. climate change effects) as well as demographic and per capita income changes. As such, they should be regarded as indicative rather than definitive.

Restoration costs

Although restoration generates benefits, it also incurs costs. These can be split into three main categories of administrative, capital and recurrent, with the latter being further split between actual expenditure and opportunity costs. Some example values for common costs are presented in Table 1, but should be regarded as indicative since costs are highly site-specific and, moreover, not always

[3] See Bateman et al (2011), for a description of economic applications for ecosystem services

[4] Note, there are basically four different notions of value, or price, used in carbon economics. The first is the marginal cost of abatement – how much it costs to prevent a tonne being emitted. The second is the market price, which is a value established in voluntary 'quasi' markets designed to limit the quantity of emissions from specified sectors or regions (like the EU-ETS). Third, the social cost, which is the 'economic' price, which estimates the economic damage done by a ton of emitted carbon. Finally, there is the shadow price, which is a government determined price to be included in policy analyses and project appraisals. The latter two are related but differ depending on Government objectives.

reported consistently (e.g. in terms of how they are classified and how areas are calculated).[5] Importantly, more expensive restoration activities tend to only apply to small areas of a given site and typical restoration costs are more modest. For example, Artz & McBride (2017) report median Scottish restoration costs for drain blocking of around £500/ha and many practitioners apply a "rule-of-thumb" figure of £1000/ha for sites requiring a mix of restoration activities. Smyth et al. (2015) present a spreadsheet-based tool to assist with estimation of total costs for a given site.

Table 1: Indicative example cost items

Category	Cost item	Indicative value
Administrative	Site assessment survey	£16/ha to £26/ha
	Professional planning service	£800/project
	Project coordination[6]	£3000 to £6000/project (plus £1000 ongoing)
	Accreditation	£700/project to £5000/project
Capital	Fencing	£5/m to £10/m
	Scrub clearance/tree removal	up to £5000/ha
	Small ditch blocking	£7.50/dam
	Revegetation	£250/ha to £4000/ha
	Lime or fertiliser application	£450/ha
	Reprofiling	£1.50/m to £2.50/m
	Bare peat stabilisation (brash)	£1700/ha to £4500/ha
	Bare peat stabilisation (geotextiles)	£9000/ha to £12000/ha
Recurrent	Monitoring recovery	up to £40/ha (but not each year)
	Intermittent remedial action	As capital above, typically at smaller scale
	Livestock management	£60/ha
Opportunity	Lower commodity output/quality	£0/ha to £100/ha
	Pest & disease problems	£0/ha to £100/ha
	Ineligibility for other support[7]	£0/ha to £300+/ha

Source: mainly derived from Smyth et al. (2015), but also Moran et al. (2013) and Bright (2017).

[5] e.g. the area affected by drain blocking, see Lindsey (2014).

[6] Administrative effort from project coordinators can represent costs of c.10% to 15% over-and-above actual capital expenditure, representing a significant additional funding requirement that should not be overlooked.

[7] The potential for support payments under the Common Agricultural Policy (CAP) to be withdrawn from part or all of a restored site represents a private opportunity cost to land managers. Although not included in calculations of public costs, they are included here as highly relevant determinants of the willingness of private land managers to enrol in restoration programmes (see also Annex A).

Administrative costs

Administrative costs are incurred in planning and implementing restoration activities. These can include site assessments, compliance with regulatory requirements and interaction with local stakeholders, and tend to be front-loaded at the very start of a restoration project but may continue at a lower level thereafter. Although actual expenditure may be incurred on items such as accreditation fees and professional services, administrative costs often mainly comprise time spent on design, consultation and communication activities. The magnitude of such costs varies with the scale and complexity of a restoration project, but indicative values fall within a range of £3000 to £6000 upfront plus £1000 per year thereafter. Some administrative costs, for example accreditation fees, may be on a per project basis and hence can form a larger share of overall costs for smaller projects relative to larger ones.

Capital costs

Some capital investment is required for most restoration projects. For example, to block drains, clear scrub and revegetate bare peat. Again, such costs are mostly front-loaded, marking commencement of project implementation, but vary with project scale and site-specific conditions. For example, the cost of blocking ditches depends on their density, width and slope, as well as the choice of materials used (e.g. plastic or wooden dams, heather bales) whilst restricted access for machinery and delivery of materials can significantly increase costs for remoter sites. Revegetation of bare peat and tree removal can be particularly expensive, but simple ditch blocking can be achievable for around £250/ha.

Recurrent expenditure

Recurrent costs are imposed by the need for on-going management and monitoring of restored sites. Monitoring is necessary to check that restoration is proceeding as planned and to identify if any remedial actions are indeed necessary; it may also be needed to comply with any accreditation procedures. Monitoring costs depend upon the frequency of inspections (e.g. annual, every five years) but also the method used. For example, inspection by land managers or volunteers is relatively cheap but may need to be supplemented by more expensive professional surveys. The use of remote sensing and/or drones may significantly reduce future monitoring costs.[8]

On-going management may include, for example, controlled grazing of livestock plus intermittent repairs to capital works. The unit cost of many on-going activities will be similar to that of initial restoration activities, albeit normally applying to less than the full site area. For example, remedial actions on failing dams or broken fencing and the removal of encroaching scrub.

On-going opportunity costs (see also Annex A)

[8] e.g. http://www.ywt.org.uk/news/2016/08/08/it-bird-it-plane-no-it's-yorkshire-peat-partnership's-unmanned-aerial-vehicle

However, whilst some on-going management costs relate to effort expended, others relate to opportunity costs, to opportunities foregone. These relate to the net value of ecosystem services currently derived from a site but which are reduced by restoration, meaning that there is a trade-off between different services.[9] In some cases, displacement may be total - for example, peat extraction for fuel or horticultural purposes has a market value[10] that is foregone if extraction ceases. In other cases, displacement may be partial – for example, livestock and crop production may be compatible with restoration, but at a different level of intensity. Equally, restoration might permit increased production, implying an(other) opportunity benefit. For example, bare peat has no agricultural production potential and unblocked grips can pose a drowning hazard to lambs and grouse chicks.

Opportunity costs are highly site-specific, depending on the profitability of current land use activities and their compatibility with restoration but also the extent to which land managers can adjust the intensity, mix and spatial arrangement of land uses. In some cases, opportunity costs will be minimal (or potentially even negative), but in other cases they may run to several hundred pounds per hectare (Moxey, 2016). As noted by one of mini-cases studies (Annex A), landlord-tenant relationships can also affect the distribution of opportunity costs (and benefits).

Cost-Benefit Analysis

Although estimates of both the costs incurred and the benefits yielded by restoration are imperfect, they are the best available and have been used in cost-benefit analysis to calculate the overall net effect. The results of such analysis reveal that there is some sensitivity to assumed unit values, and to the length of time over which costs and benefits are considered, but that in general restoration is socially worthwhile. That is, the benefits to society outweigh the costs. Moreover, the cost-effectiveness of peatland restoration compares favourably to some other mitigation options, such as afforestation or biogas (Moxey, 2011).

Endorsement of the economic merits of restoration has been obtained in studies considering only a sub-set of ecosystem benefits, typically climate and water regulation, but is stronger when a wider range of ecosystem services are considered and if the longer-term accrual of benefits is considered, particularly if predicted climate change effects are included (Grand-Clement et al., 2013; Moxey & Moran, 2014, Smyth et al., 2015).

Hence, for example, Harlow et al. (2012) estimated a benefit:cost ratio of between 1.3:1 and 2.9:1 over a 25 year period for a site in Yorkshire, Pettinotti (2014) estimated ratios of up to 4.9:1 for Scottish sites over the period to 2080 under climate change, the Natural Capital Committee reports 4:1 as typical and Bright (2017) estimated 9:1 for a 100 year period or 12:1 for a 300 year period for Exmoor. Such results highlight spatial variability due to site-specific factors as well as precise methodological approaches, but do demonstrate the general economic merits of restoration. This confirms the rationale for allocating funding to restoration activities.

[9] This logic is based on cost benefit analysis. Landowners are faced with different management options to deliver their desired outcomes. Each option will entail different costs and benefits. The measure of the 'best' alternative must take into consideration the net benefits associated with the alternative options.

[10] Although the UK government's commitment to peat-free compost by 2020 (retail) and 2030 (commercial) will reduce the horticultural opportunity cost of extraction.

An alternative way of illustrating this type of analysis is shown in shown in Figure 1. Each vertical blue bar represents the difference between the present value[11] of estimated on-going benefits and on-going costs of restoration under a given climate change scenario. The height of the bar reflects possible variation in the net present value of benefits according to whether high or low unit costs and high or low unit benefits are assumed.

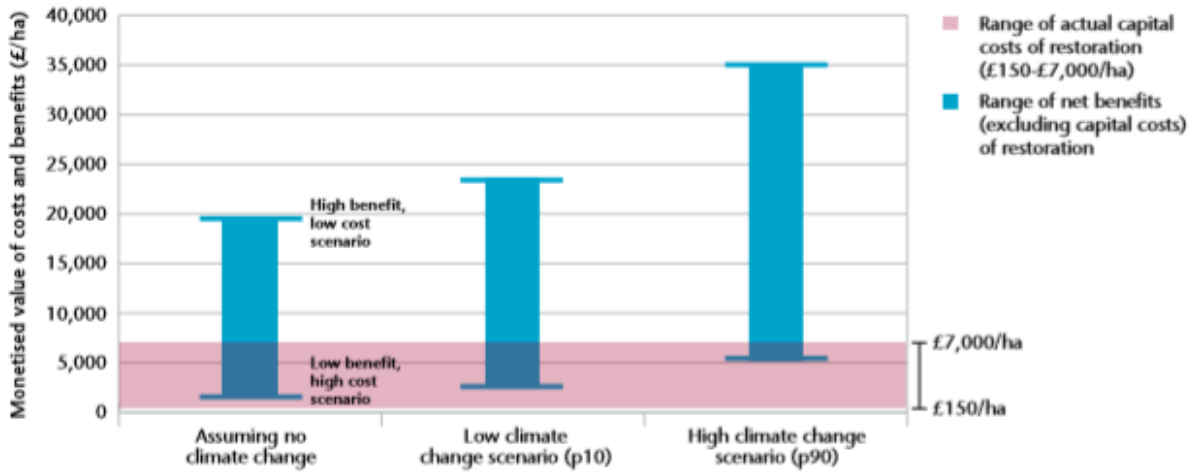

Figure 1: Summary comparison of costs and benefits of restoration, under climate change scenarios.

Source: Adaptation Sub-Committee, 2013.

In all cases, the net on-going benefits are positive, but increase with the assumed severity of climate change. However, upfront capital costs also need to be considered and are shown by the pink horizontal bar. Where the pink bar overlaps with the base of a blue bar, total costs exceed benefits and restoration is not economically cost-effective but where the blue bar extends above the pink bar, restoration is merited. This indicates that restoration, which may desirable on ecological grounds, may not be merited economically for all sites. It also, however, highlight how climate change increases the economic rationale for restoration across all sites.

Importantly, the baseline comparator against which restored sites should be compared is not static. Rather, an already-degraded peatland is not necessarily stable but can be subject to continued (and possibly accelerating) deterioration. For example, gulleys can widen and areas of bare peat can expand, leading to increased carbon emissions and further loss of other ecosystem services. Equally, restoration is not a one-off event but a process, with site condition (and functionality) improving over time. This means that the benefits of restoration are not simply the difference between static before-and-after situations, but the difference between two evolving paths - with the magnitude of restoration benefits depending on the divergence between the two.

[11] Because the flows of costs and benefits extend into the future but with different profiles over time, comparisons are based on present values calculated by applying a discount factor to each future value and then summing all discounted values up to some time horizon. However, discounting underplays benefits extending far into the future, ignoring the greater durability of functioning peatlands compared to, for example, wind turbines or solar panels.

Figure 2 offers a stylised illustration of this in terms of carbon emissions, although the actual slopes and indeed shapes of the paths would be expected to vary across different sites.[12] For example, to reflect difference in initial conditions, restoration intensity and climate change effects. Figure 2 also shows the significance of emissions avoided as well as new sequestration to overall benefits, highlighting how early benefits can be realised before restoration has recovered full functionality. The possibility of early (if partial) benefits and the fact that restoration costs increase with severity of degradation suggest that cost-effectiveness is likely to be greater for early rather than delayed actions.[13]

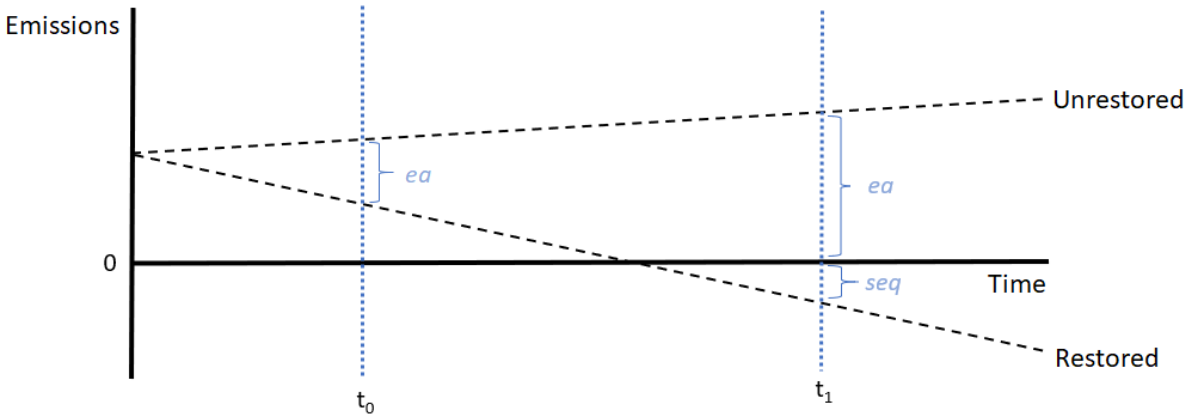

Figure 2: Stylised time-paths for estimating restoration carbon benefits.

Emissions at time t_0 are still positive after restoration has commenced, but lower than if the site had remained unrestored, thus yielding carbon benefits in the form of emissions avoided (ea). As site condition improves further, emissions avoided increase but are supplemented by new sequestration (seq) to yield greater overall benefits. The emission lines could take various shapes.

Public funding

Introduction

The complex, inter-related nature of often intangible and/or diffuse ecosystem services associated with peatlands, plus practical difficulties in restricting them solely to individuals or businesses paying directly for them, underpins assumptions that benefits have to be funded[14] from general taxation rather than private sources. That is, the public good nature of many ecosystem services and "jointness" in delivery between many of them has hindered voluntary market-based payment

[12] And for other benefits.

[13] An analogy may be drawn with replacing a missing roof slate at once rather than waiting until further damage has occurred. Asymmetry in the rates of carbon loss and sequestration matters: it takes a long time to accumulate but can be lost rapidly, just as putting marbles in a jar is slower than tipping them all out again (after Pete Smith).

[14] Although it should be noted that policy instruments include regulatory "sticks" as well as funding "carrots".

systems, leading to public funding dominating UK peatland restoration and management expenditure (but see below for private funding).[15]

Although dedicated domestic funding programmes have emerged in recent years and some activities have been delivered through EU-project funding, public expenditure on peatland management and restoration is currently dominated by the Common Agricultural Policy.

Common Agricultural Policy

Public funding of land management under the Common Agricultural Policy (CAP) is split unevenly between two "Pillars", with Pillar I accounting for the bulk of expenditure (c. £2.8bn/year across the UK over the period 2014-2020) and funded via the EU. The smaller Pillar II budget (c. £0.3bn/year across the UK over the period 2014-2020) is funded jointly by the EU and domestic governments. Although all operating under the CAP's common framework, each constituent part of the UK has implemented it in slightly different ways to reflect local circumstances and priorities.[16] This has led to some variation in the type and level of Pillar I support available.

Pillar I support takes the form of area payments, currently referred to as the Basic Payment but previously termed the Single Farm Payment, available to almost all UK farmers. Whereas support was historically tied or coupled to actual production levels (e.g. a payment per sheep), compliance with World Trade Organisation (WTO) rules now requires that Pillar I support has to be (mainly) "decoupled", meaning that support is received regardless of actual production patterns. Although the EU has encouraged convergence of payments rates, they vary across different types of land and also between different parts of the UK, ranging between less than £10/ha and almost £300/ha (see Annex A).

Support is conditional on observing a number of management requirements (i.e. "cross-compliance", "good agricultural and environmental condition", "greening") intended to maintain or improve aspects of, for example, soil quality and biodiversity, but the requirements are generally regarded as weak. Thorp et al. (2013) compared Pillar I management requirements across the UK and concluded that they were very similar, but largely irrelevant in terms of the specifics of positive peatland management and restoration. Moreover, Moxey (2016), noted that variation in the criteria used to judge the eligibility for Pillar I payments could potentially have a negative effect by inhibiting some restoration activities (see previous comments on opportunity costs). For example, if parcels of land become too wet to be grazed and therefore ineligible for Pillar I support.

Unlike Pillar I, Pillar II funding is only available via a competitive application process that seeks to target support rather than offer blanket coverage. This is achieved through a number of distinct measures operating within a Rural Development Programme required to have clear objectives and

[15] In principle, different ecosystem services could be marketed separately as different "layers" in a "stack" or "bundled" together according to market demand (Bonn et al., 2014). In practice, a number of issues arise with such approaches and, pragmatically, one benefit is typically emphasised with others treated as accompanying "piggy-back" co-benefits.

[16] A point that perhaps needs to be remembered in domestic debates about a possible common framework across the UK post-Brexit.

targets. Funding is available for a range of measures, including training, farm modernisation and diversification. However, successive reforms of the CAP have increased the emphasis upon agri-environmental objectives and the bulk of UK Pillar II expenditure is under agri-environmental schemes designed to maintain and enhance various aspects of the farmed environment, including peatlands.

Agri-environment funding is available both for capital works and for on-going management, with payment rates pegged to cover costs incurred and any income foregone. For example, the costs of capital items and their installation plus any reductions in profit arising from changing the type or intensity of farming activities. This approach to calculating payment rates is part of the CAP rules, but is a WTO requirement under the prevailing international Agreement on Agriculture (which will still apply post-Brexit), and is one factor influencing land managers' willingness to enrol in restoration projects (Smyth et al., 2015).

Each part of the UK has its own Rural Development Programme, devised to suit local circumstances and priorities. For example, the nature and cost structure of different farming systems and the relative importance of different habitats. Consequently, although the menu of policy measures prescribed by the EU is the same in all cases, the precise design of policy schemes varies slightly in terms of both management requirements and payment rates.

Nevertheless, each part of the UK has a set of supported activities relevant to peatland management and restoration. For example, annual support of around £0.75m is paid on heather and moorland in Northern Ireland whilst Wales has targeted £20m for peatland management and restoration over the period 2014-2020. Similarly, in England, current schemes have paid around £18m for restoration activities plus annual maintenance payments of around £22m, with up to 0.5m ha being enrolled in schemes in Scotland where annual support payments average £0.3m. Although some of the expenditure is capital works, for example £1.8m on grip blocking in England under the current RDP to-date, much of it is in relation to on-going (opportunity) costs and may not necessarily follow explicit restoration activities.

The UK's withdrawal from the EU following the Brexit referendum result of 2016 creates new opportunities but also considerable uncertainty around the level of future funding likely to be available for land management and how it will be targeted at particular objectives, with possible implications for peatland restoration. For example, if Pillar I support is reduced or abolished, the risks of forgoing Pillar I payments through restoration could ease, making restoration relatively more attractive, although pressures for intensification might occur in some locations. Moreover, unless Pillar II type funding remains in place, it is unlikely that active restoration and management will be undertaken. Whilst the rhetoric of public money for public goods is compatible with funding restoration, budget constraints and competing demands will likely influence the overall funding available.

On behalf of the RSPB, the National Trust and the Wildlife trusts, Rayment (2017) estimated the amount the UK needs to spend on agri-environment schemes to meet its environmental commitments. Within that work there was an estimate of the amount of peatland that would need to be created, restored and maintained to meet UK commitments. Pulling out, from that analysis, the yearly costs for: Upland Flushes, Fens and Swamps, Purple Moor Grass & Rush Pastures, Lowland Fens, Reedbeds, Lowland Raised Bog and Blanket Bog come to around £124 million/year.

In early 2018, the UK Government published its 25 Year Environment Plan. 'A Green Future'. Defra subsequently published a consultation, or 'command' paper on the future of agriculture policy in England after the UK leaves the European Union (EU), entitled "Health and harmony: the future for food, farming and the environment in a Green Brexit". Both documents commit the government to the principle of "public money for public goods" principle with environmental protection as the "cornerstone" of any policy. Similar policy statements have emerged from Northern Ireland, Scotland and Wales, albeit with slightly differing emphasis to reflect regional circumstances (e.g. McCormick et al., 2018).

Public money for public goods achieves two things. Firstly, it removes perverse incentives to farm uneconomic land simply to receive the basic payment. Secondly it specifies the only justification for spending public money is to buy public goods – freeing up much needed cash. If that position remains stable we should expect a new agriculture policy in England which moves significantly towards meeting the financial needs of peatland, with potentially similar moves in the Devolved Administrations.[17]

The consultation paper describes the need for a UK-wide common framework for agricultural policy. A new framework should help prevent a race to the bottom and encourage support for the environment across the UK if Devolved governments agree to the broad direction and on the need for a framework.

Other peatland-specific programmes

Following Ministerial-level commitments to set ambitious targets for peatland restoration across the UK, additional funding has been made available for specific programmes. This reflects recognition of the limited funds available through current RDPs, given their finite budgets and competing demands, but also frustration with the time taken and some operational constraints associated with Pillar II funding.

For example, Peatland ACTION in Scotland has restored over 10,000 ha of peatlands since its introduction in 2012, with a target of 7500 ha and a budget of £8m for 2017/18. This has accelerated the pace of restoration by making it easier to undertake planning activities and capital works, but is still reliant on RDP funding to cover on-going costs. Similarly, Defra have made £10m available to Wildlife Trusts and charities for restoration projects over the period 2018-2021. The interaction between peatland-specific and more general RDP funding can be complicated, so replacement of the CAP by domestic schemes after Brexit perhaps offers an opportunity to streamline restoration funding.

While Brexit has placed future LIFE funding in a state of uncertainty, currently Natural England estimates the UK's potential share of LIFE funds at £31million per year. Over the last 5 years UK projects have obtained an average of £16 million per year from LIFE. Suggesting that with a focussed effort on high quality projects – and work to find matched funds more money could be obtained from LIFE for peatland projects. In addition, it argues for a future scheme or schemes in the UK of that order to ensure that nature is no worse off.

Separately, UK peatlands have benefited from EU LIFE+ funding in the past, and a number of projects continue to run (although participation in new projects after Brexit is uncertain). For example,

[17] Although at the time of writing, post-Brexit arrangements for devolved policies remain highly uncertain.

current Bog-Life, MoorLife and PeatLife projects in England have received over £11m of LIFE+ funding (leveraging-in a further £8m from other sources) to actively restore over 4200ha and indirectly benefit a further 6500ha.

Other public funding

Smaller sums of public funding are also available from other sources. In particular, some expenditure on peatlands lying within designated sites such as SSSI/ASSIs occurs either through direct management by public bodies or as discrete payments under management agreements with farmers or other land managers. However, the trend is for management agreements to be moved into agri-environmental schemes and total expenditure on them has declined.

Private funding

Introduction

The public goods nature of many ecosystem service benefits arising from peatlands means that public funding has dominated most UK restoration efforts to-date. That is, the often intangible and/or diffuse nature of benefits plus difficulties in restricting them solely to individuals or businesses paying directly for them have traditionally underpinned assumptions that they have to be funded from general taxation or controlled through regulation.

However, recognition of the overall funding levels needed to achieve ambitious restoration targets and of competing pressures on public budgets has prompted interest in developing ways in which private funding might be attracted to restoration projects. This reflects wider trends, both domestically and internationally, to expand the role of private funding in securing a range of social and environmental benefits. For example, climate change mitigation, expansion of educational opportunities and reductions in criminal reoffending.

In the UK, austerity and reduced public sector budgets have transformed public service delivery in recent years. Sub-national authorities are increasingly becoming commissioners, rather than providers of public services. The Localism Act (November 2011), the Public Services Social Value Act (March 2012) and the Open Public Services white paper (July 2011) all lean towards the public sector operating much more as commissioners, not a provider of services, encouraging a greater diversity of potential providers into a range of social and environmental services. This trend has been most apparent in the social sector where service providers, often charities, agree contracts, or enter into financing agreements, like social impact bonds, where government pay for performance related outcomes. There are examples of such programmes in health education and prisoner rehabilitation. There are clear parallels with socially valuable outcomes related to restored peatlands (enhanced biodiversity, flood moderation, carbon stored).

An often-stated ambition of government investment is the intention to use government funds to ‘crowd-in’ further private sector contributions. Governments have also tried a number of novel approaches to try to create markets to incentivise the delivery of public goods. Some rely explicitly on regulatory interventions to create markets. For example, the European Trading Scheme (ETS)

carbon compliance market.[18] Other possible markets, like compensating for biodiversity loss through development (biodiversity offsetting) have been promoted in the UK but the lack of regulation has limited progress. Both government and private organisations have sought to incorporate (valorise) public benefits into the market premiums paid for food, timber or tourist experiences associated with particular areas or modes of production.[19] For example, quality assurance and branding of local and/or environmentally-friendly products. Alternatively, attempts can be made to attract charitable donations. For example, through public fundraising campaigns or voluntary charges at specific sites.

Although such mechanisms may have some potential for UK peatlands, more active consideration has been given to approaches that offer a financial return to voluntary investments in restoration. In particular, 'Payments for Ecosystem[20] Services' (PES) but also possibly 'Green Bonds', both of which are discussed briefly below. The use of market mechanisms and financial instruments to fund environmental protection and improvement is not uncontroversial, with criticisms focusing on the technical challenges but also more fundamentally on ethical concerns about monetising non-market benefits. These perspectives are not considered further here, but may influence the further development of private funding for peatland restoration.

Payments for Ecosystem Services

In a market, buyers purchase goods and services from sellers in mutually beneficial exchange, a system that generally caters reasonably well for many provisioning services offered by ecosystems. For example, food production. However, due to a variety of understandable reasons, markets typically fail to form for other ecosystem services. For example, regulating service benefits are difficult to measure precisely, are often produced jointly with other benefits and it is difficult to prevent anyone not paying from still receiving the benefits. Markets work well for simple, separable goods and services, like pizzas or haircuts. They do not work for complex goods with network features, interdependencies and with complex time and spatial considerations in terms of the origin of the benefit and the experience of the benefit by people. Beyond government provision, market-based approaches still require clear regulatory frameworks, as with the UKs regulated water, energy or telecommunications markets.

Without regulation or incentives, many ecosystem services still arise as externalities with beneficiaries (e.g. households) not paying for them and providers (e.g. land managers) not being paid for generating them, a situation that leads to neglect and under-provision of services. PES are an attempt to overcome this problem, to internalise externalities and to establish a financial linkage connecting beneficiaries and service providers. Internationally, PES are also often intended to alleviate rural poverty.[21] In the UK the challenges will establish PES for ecosystem services has been highlighted by Defra trials conducted between 2010 and 2015. Thirty Pilots were supported, none led to the creation of a sustainable market.

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[18] This is based on a cap and trade mechanism, and excludes land use sectors.

[19] Visitor giving schemes are a good example of this approach. See Visit England

[20] Sometimes termed 'Environmental' or 'Ecological' but use of 'Ecosystem' predominates, reflecting widespread adoption of the Ecosystem Services framework.

[21] For example, although extending beyond PES, the Gold Standard for climate and development funding, https://www.goldstandard.org/

As a concept, PES are closely related to a variety of market-based instruments but have emerged as a distinct category in their own right over the past two decades or so. They can vary greatly in scope and ambition, seeking to establish payment mechanisms for single or multiple service benefits and/or combining (bundling)[22] benefits to be charged for jointly or separating (layering) them for charging individually. Definitions vary slightly but generally include:

- Payments are made to ecosystem service providers;
- Payment is made by the beneficiaries of ecosystem services;
- Service providers enter into a PES agreement on a voluntary basis;
- PES benefits are additional to those required by regulatory compliance;
- Payment is conditional on the delivery of ecosystem service benefits;

In practice, conditionality is often expressed in terms of adherence to management prescriptions rather than harder-to-monitor effects which can be separated by time and distance from management actions. Equally, payment by beneficiaries is often coordinated through intermediaries such as utility companies or government agencies, with the latter effectively extending the PES definition to also include many pre-existing agri-environment type schemes. Indeed, many international PES involve government agencies and are not strictly attracting private funding.

The Peatland Code

Responding to recommendations in the Lawton Review (2010) to develop market approaches to realising a range of ecosystem benefits, Defra commissioned a set of pilot PES projects in England (Defra, 2016) as noted above. These covered a variety of locations and environmental goals, including peatland restoration. Whilst not strictly a PES scheme the latter contributed to development and launching (in 2015) of the Peatland Code under the IUCN Peatland Programme.

The Peatland Code (PC) is a voluntary standard for UK projects seeking to market the climate benefit of peatland restoration. Although restoration potentially delivers a range of service benefits, climate benefits were chosen as the primary focus because carbon emissions already have a market value. Specifically, voluntary[23] markets already exist to facilitate valuation of carbon emission savings.

As such, the PC seeks to attract investors interested in the potential financial return to carbon savings. In this, it follows the example of the UK Woodland Carbon Code (WCC) which seeks to attract private funding into woodland creation through marketing carbon emission savings as an additional investment opportunity over-and-above returns from timber production. However, in both cases, investors may be motivated by other considerations, including Corporate Social Responsibility (CSR) and/or interest in other ecosystem service benefits. Waylen & Martin-Ortega (2018) report that environmental professionals are cautiously supportive of, and expect, increased use of land management PES within the UK, but that opinions differ about the pros and cons, and the degree of overlap with conventional agri-environment schemes. Reed et al. (2017) highlight how governance arrangements and tailoring to local circumstances can influence PES outcomes.

[22] Within this, some might not be charged for explicitly, 'piggy-backing' on paid-for benefits. Analogies can be drawn with telecommunication marketing strategies.

[23] Compliance markets also exist, but peatland emissions are not eligible for these – if they were, higher carbon prices could be obtained.

To attract private investors, the PC presents a set of best practice requirements, including for quantification of emissions savings, calculation of risk 'buffers' to accommodate measurement imprecision and possible restoration flaws, and provision of independent validation. The latter is important since investors require credible assurances that carbon savings are genuine and additional. Importantly, enrolment under the PC incurs some additional costs, meaning that net additional funding is less than implied by the gross level of private funding attracted.[24] Although in principle private funding might support entire restoration projects, relatively low voluntary carbon market prices mean that PC funding can realistically only be part of a funding package. For example, depending on risk buffers, current voluntary carbon prices imply a gross level of funding under the PC of between about £2/ha/yr and £6/ha for many sites (Smyth et al., 2015). Higher rates may be achievable for actively eroding sites, but these typically have higher restoration costs too.[25]

Marketing of the PC (and the WCC) to potential investors entails considerable effort in identifying suitable projects and suitable investors and then negotiating mutually-acceptable terms and conditions. For example, with respect to project duration and effective carbon price. This typically requires the involvement of an independent broker, including sometimes direct shouldering of financial responsibilities and risks to facilitate progress.

There is reason to believe that investor interest will grow in investments which deliver social and environmental impact. The RSPB (2018) interviewed a number of investors across the financial system and identified significant interest to do more. The concept of Environmental, Governance and Social (ESG) investment is well understood and the UNs Sustainable Development Goals (SDGs) are motivating action and influencing investment flows. According to the UK Government's advisory group on social impact investing, the rise in popularity of ESG investing has been accelerated by a number of broader trends, including an increasing focus on climate issues, supported by agreements such as the Paris Climate Accord. The advisory group estimate that the UK impact investing market, including both social and environmental impact, is currently worth £150 billion.

Environmental degradation is symptomatic of the same market failings and requires the same attention. As with climate change, the Finance sector is uniquely placed to make a difference. Investors will, wittingly or unwittingly, be exposed to economic losses consequent on widespread ecosystem degradation. The Finance sector is, however, also uniquely positioned to improve natural capital outcomes through the opportunities they can derive from developing products and services which yield both positive environmental and financial outcomes.

Together with its collaborating partners, the Natural Capital Finance Alliance has already developed a number of tools and resources to aid different types of financial institutions to incorporate natural capital considerations within their business decision-making There are also a number of studies concluding that good ESG practices can result in better operational performance and therefore it is now increasingly common to integrate sustainability factors into investment analysis and management. To-date, although there has been some interest in the PC, only one project has formally signed-up under it. This partly reflects the time and effort generally taken to negotiate

[24] Although it is possible that some of the costs of operating the PC might be covered by an NGO or government agency – the latter happens under the German Moors 2.0.

[25] Carbon values are driven directly by estimated emission savings, which are highest for actively eroding sites. This possibly implies that PC funding is most suited to such sites, or that actively eroding sites need to be packaged with other sites to extend the spatial coverage of the PC.

agreements and the relative newness of the PC.[26] However, it also reflects some issues regarding interactions between public and private funding. In particular, demonstrating additionality – that restoration would not occur without private funding – is often difficult given the existence of various support measures funded by government agencies. For this reason, existing projects can not apply for retrospective PC funding. Accommodating additionality requirements can involve, for example, improving projects and/or forgoing some public funding.[27] Nevertheless, interest in the PC is expected to grow as it become established and other funding streams possibly change.

Voluntary Carbon markets have been in decline for some years. In 2017 there was as much carbon left unsold as was sold. Prices vary widely at between $0.50 and over $50 per tonne CO_2e[28]. That difference may reflect prices for the other goods provided alongside the carbon. Land management offsets, which often offer a range of ecosystem services, are amongst the more expensive credits.

From 2021, however, there may be an increase in demand for carbon offset credits as international aviation will be required to offset any increase in emissions over 2019/2020 levels[29]. The rules on accreditation have not yet been set but they are likely to be relatively stringent making the Peatland Code more relevant. The expected volume stands at approximately 2.5 gigatonnes CO_2e from 2021 to 2035. Expected demand would roughly double demand for offsets from the voluntary market but only return it to something approaching the height of the market at 130 megatonnes CO_2e per year. Whether this has a significant impact on prices will therefore depend upon how stringent the accreditation rules are as they should rule out cheaper credits with poor additionality.

Club Payment Ecosystem Services (PES)

Although the Peatland Code has received significant publicity as a PES, it is actually pre-dated by a few local examples within the UK focused on water management. Whereas the climate regulation benefits targeted by the Peatland Code are global in nature, the benefits arising from water management are typically contained more locally within a river catchment. This makes it easier to identify who benefits from improvements and to devise payment mechanisms to charge for them. This means that although the benefits still have some public good characteristics, free-riding is harder.

Economists refer to such examples as 'club goods' – benefits are restricted to those paying for them but (within limits) are not diminished by individual beneficiaries' use. Some high-profile international PES relate to water benefits. For example, the cases of New York City's Watershed Agricultural Council in the USA,[30] whereby appropriate land management practices are incentivised through private funding to reduce pollutant loadings, thereby avoiding the need for downstream treatment works and retaining consumers' faith in water quality. Proposals for Natural Infrastructure Schemes (NIS)[31] fall into this category.

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[26] By comparison, when the UK Woodland Carbon Code was launched, the concept of forest carbon was already well-established and around 40 suitable projects were already available for accreditation.

[27] For example, paying for additional capital works or extending project duration.

[28] https://www.cbd.int/financial/2017docs/carbonmarket2017.pdf

[29] https://www.icao.int/environmental-protection/Pages/EmissionsTrading.aspx

[30] https://www.nycwatershed.org/about-us/overview/ See also Salzman et al. (2018)

[31] http://www.green-alliance.org.uk/resources/New_markets_for_land_and_nature.pdf

Depending on the relative abundance and spatial distribution of peatland within a catchment, degraded peatlands can affect both the water quality within a catchment and the pattern of how it flows over time. For example, peaty water is often discoloured whilst bare peat has less capacity to hold or slow runoff, affecting base and peak flows. These problems can be addressed through downstream water treatment and low flow/flood management measures. Alternatively, upstream peatland restoration can be used to mitigate downstream effects. Both approaches incur costs, but the potential greater cost-effectiveness of (at least partially) replacing traditional downstream capital investments with upstream land management has gained traction in recent years. This has been facilitated by the advent of River Basin Management Plans (RBMP) under the Water Framework Directive (WFD) and by cultural shifts within organisations towards acceptance of softer rather than hard, technical (end-of-pipe) solutions.

The beneficiaries of improved water quality and flow management are households and businesses within affected catchments, with payment collected through established mechanisms such as water rates and taxation. Intermediary bodies such as water companies or local councils collect payments and use them to fund mitigation activities on behalf of beneficiaries, meaning that (unlike under the Peatland Code) a body[32] may already exist to liaise with land managers and costly quality assurance mechanisms are avoided. Gaining regulatory approval to use water customers' payments for land management purposes initially took some time, but is now accepted and more water companies have begun to explore and expand PES-related activities.[33]

For example, South West Water plans to increase spending on its award-winning 'Upstream Thinking' from £9m to £14m for 2015-2020 and to enrol a further 750 farms and 1300 ha[34] whilst the third phase (ScAMP 3) of United Utilities' award-winning sustainable catchment management programme is also increasing enrolment of private farmland through targeting 29 drinking water safeguarding zones.[35] Similarly, Scottish Water is continuing with its Sustainable Land Management Incentive Scheme (SLMIS).[36] In each case, although not restricted solely to peatland areas,[37] such schemes are securing additional funding for restoration activities.

As with the Peatland Code, although the main emphasis of these schemes may be on one or two specific water-related benefits, it is recognised that restoration potentially yields gains across a wider range of benefits, including carbon emissions and biodiversity. Equally, administrative interactions between different funding sources and demonstration of additionality can be problematic, as with the Peatland Code. Indeed, some commentators question why land managers already in receipt of Pillar I support under the Common Agricultural Policy (CAP) should receive additional payments rather than simply having additional conditionality imposed on their existing

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[32] Although interactions between water companies, local councils, environmental agencies and government agricultural departments can add complexity to this.

[33] For example, under the Asset Management Plans (AMPs) approved by Ofwat for English water companies.

[34] https://www.southwestwater.co.uk/globalassets/document-repository/waterfuture-archive/south-west-water-business-plan.pdf

[35] https://www.unitedutilities.com/corporate/responsibility/environment/catchment-management/

[36] http://www.scottishwater.co.uk/assets/about%20us/files/corporate%20responsibility/slmis_wemp_specification_doc.pdf

[37] Over the period 2010 to 2015, water companies spent around £60m on catchment management, of which perhaps two-thirds related to upland peatlands.

support arrangements. Nonetheless, such club PES already have an important role in contributing to peatland restoration in the UK and are likely to continue to do so.

Green Bonds

A Bond is a financial security issued by companies or governments as a means of raising finance, usually for longer-term investment projects. The issuer usually commits to repaying bond holders the face value of the bond at a pre-specified future maturity date plus to making an annual interest payment. The annual payment is fixed in absolute terms but can vary in percentage terms if bonds are tradable (e.g. if a bond's traded value rises above face value, the fixed annual payment will represent a smaller percentage of the bond's value).

In an effort to explicitly attract investors wishing to better balance their need for financial returns with concerns about wider societal issues, efforts have been made over the last 10-20 years to adjust the traditional bond concept. This has led to the introduction of, for example, social impact and green bonds. Green Bonds have been issued by sub national authorities, particularly in America, Financial intermediaries, Private businesses, like water companies and even charities. These are not necessarily tradable and the funds raised are generally ring-fenced to specific (and closely monitored) projects, with the financial return offered to investors possibly contingent on the project achieving specified outcomes. As such, they may offer lower and riskier returns than conventional bonds, yet may still be attractive to some investors motivated by ethical or Corporate Social Responsibility (CSR) concerns. Repayment of the bond and any interest payments may come from public funds and/or from revenue generated from the project.

Internationally, government and corporate green bonds have been issued for a variety of environmental projects, including climate change mitigation and adaptation for which they are sometime referred to as climate bonds.[38] As such, green bonds have some potential as a source of private funding for peatland restoration, alongside other themes such as renewable energy generation or promotion of energy efficiency. However, as with PES, investor confidence depends on assurances about project design, additionality and outcomes and although the metrics and procedures developed under the Peatland Code would presumably be similarly appropriate for a bond, they would need to be compatible with emerging international criteria/standards for bonds.[39]

Whether peatland restoration bonds would be more or less attractive to investors than a peatland PES is difficult to judge in abstract. Given that the underlying peatland assets and potential revenue streams would be the same under either approach and that similar issues will arise with respect to interactions with public funding, other factors would determine relative attractiveness. In principle, because bonds are a more familiar form of financial asset, green bonds linked to peatland restoration might attract greater overall interest amongst portfolio investors than the typically more bespoke and individually-negotiated PES approach. Indeed, part of the attraction of green bonds is their potential to tap into existing capital markets rather than new instruments such as PES, and to cater for varying scales of investment.

[38] Climate Bonds Initiative https://www.climatebonds.net/files/files/CBI-HSBC%20report%2010Nov%20JG.pdf
[39] Climate Bonds Initiative https://www.climatebonds.net/standards/about

This means that a restoration project could, potentially, attract a larger number of investors with more diverse motivations and investment (and risk) appetite through a bond. For example, a mix of individuals holding a few bonds and companies or institutional investors with more substantial holdings, motivated by different considerations. In addition, if bonds are tradable, investors may (depending on market conditions) have greater freedom over the timing of making and realising investments (i.e. liquidity may be higher than with a PES). Such flexibility may be attractive to investors. However, flexibility typically incurs higher administrative costs which have to be covered, either by project managers or by investors. As with a PES, the effort required to design and market a restoration bond-funded package may be considerable, including probably needing the backing of an issuer approved by the Financial Conduct Authority. Consequently, the scope for using green bonds for funding peatland restoration would require further research before any implementation could be considered.

Conclusions

Functioning peatlands deliver a range of ecosystem services, including climate and water regulation. The economic value of many of these is not generally recognised by markets and consequently many services have diminished over time as peatlands have degraded under management focused on only a small sub-set of services, notably commodity production.

However, restoration activities can recover the capacity of peatlands to deliver the wider range of ecosystem services. Although not costless – incurring a mix of upfront and recurrent costs – economic analysis confirms that restoration merited in most (but not all) cases. Estimated cost-benefit ratios vary according to site conditions and the range of ecosystem services considered but are often strongly supportive, particularly if climate change effects are considered. This provides a strong public policy rationale for continued funding of restoration activities, ideally for quick interventions to reap early gains and avoid the higher damage and higher restoration costs of continued degradation.

Current funding draws on a variety of sources, including agri-environment schemes under Pillar II of the CAP, peatland-specific government programmes and catchment management initiative funded by water companies. All have a role to play and will remain important. However, the magnitude and nature of agricultural policy post-Brexit remains uncertain and future support for peatlands has yet to be clarified. However, political rhetoric about “public money for public goods” and possible reductions in direct payments should favour restoration activities. It is not yet clear whether regulatory controls relating to environmental conditions will be increased or decreased post-Brexit.

In addition, recognising on-going public-sector austerity and the scale of restoration ambitions, there is some interest in attracting supplementary private-sector funding. In particular, the Peatland Code has been developed and launched to this end and Green Bonds may have some potential. However, further development of such approaches is required and overall reliance on public-sector funding is likely to remain the norm.

Notwithstanding the demonstrable benefits of restoration, there is scope for further refining economic analysis. For example, funding data are not always readily available. Perhaps more importantly, valuations of benefits remain relatively scarce and are difficult to compare due to methodological differences. It would be helpful if existing studies could be repeated for other sites,

to extend the breadth of comparable valuation data. Similarly, although improving, available cost data continue to suffer from ambiguities regarding how particular cost items are categorised and unit areas calculated. Again, it would be helpful if some standardisation could be achieved. Finally, despite their likely influence on land managers' willingness to undertake restoration, data on opportunity costs remain particularly elusive, even in the form of descriptive case studies, and still require further exploration.

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Annex A: Opportunity costs[40]

A1. If the act of restoration affects the continuation of a current income-generating activity on a given peatland site, that income is (partially or completely) foregone; there is an opportunity cost to the land manager. This may take the form of a loss of commercial production (e.g. reduced agricultural output) and/or the loss of public support payments.

A2. Eligibility for support payments is a major concern for land managers, with payments under Pillar I of the Common Agricultural Policy often representing a significant proportion of farm incomes. Table A1 summarises estimated indicative payment rates for the Basic Payment Scheme (BPS) in 2019 across the UK, highlighting geographical variation but also the magnitude of potential losses if restoration removes eligibility for continued support.

Table A1: Indicative Basic Payment (including Greening) rates for 2019

	Euro rate	Sterling rate
England		
Lowland (non-SDA)	€248/ha	£221/ha
Upland (SDA, non-moorland)	€247/ha	£220/ha
Upland (SDA, moorland)	€65/ha	£58/ha
Northern Ireland	€330/ha	£294/ha
Scotland		
Region 1 (non-LFA)	€244/ha	£217/ha
Region 2 (LFA, grade B, C or D)	€41/ha	£36/ha
Region 3 (LFA, grade A)	€13/ha	£12/ha
Wales	€243/ha	£216/ha

Notes: Capping may reduce effective per ha rate on larger Scottish holdings; Welsh rate on first 54ha only, c.€124/ha thereafter. Assumed exchange rate of £0.89.

A3. Policy guidance across the UK suggests that restoration should not affect eligibility for support, but this is not necessarily comprehensive or consistent. For example, interpretations of whether land with bracken/scrub/heather/open pools remains available for agricultural use and/or is being actively managed can vary. As a result, at least some land managers perceive a risk of losing support payments.

A4. Moreover, the perceived risk will increase with higher payment rates. Ironically, the recent trend to increase payment rates on poorer land increases the potential disincentive effect on enrolment if eligibility is perceived to be at risk. If Pillar I-type support is reduced or removed after Brexit, this issue will become less important.

A5. The effects of restoration on the productivity and profitability of commercial activities can be harder to discern. Some activities, such as peat extraction, are clearly incompatible and will cease but others

[40] See also Moxey (2016) for a fuller discussion

are at least partially compatible. For example, livestock grazing and grouse shooting can continue on restored sites, but their productivity may be affected.

A6. Productivity may be affected in different ways. For example, if fewer animals can be kept and/or their growth rates are diminished due to an increased incidence of pests or diseases[41] and or reduced availability of grass or invertebrate food sources. Conversely, it is also possible that restoration could increase productivity. For example, revegetation of bare peat increases grazing value.

A7. Unfortunately, robust data on opportunity costs are scarce.[42] This partly reflects the absence of widespread monitoring, but also genuine difficulties in attributing observed year-on-year changes to one particular cause. For example, weather and market conditions also influence productivity and profitability. Moreover, whereas some sites may be highly productive, at least some are not currently in productive use or are of only low productive value – meaning that opportunity costs will vary somewhat.

A8. Table A2 presents estimates of average Gross Margins[43] (revenue minus variable costs, ignoring family labour and overheads) as an indicative guide to the magnitude of potential income foregone if restoration reduces the productivity of grazing enterprises. Actual values for a given site will vary greatly. Equivalent figures for grouse moors are less readily available but may lie in the range £20/ha to £100/ha.

Table A2: Indicative Gross Margins (£/ha) for livestock grazing enterprises (2015/16)

	Cows		Ewes	
	Low ground	Hill	Low ground	Hill
England	£217	£179	£255	£99
N. Ireland	£325	£248	£398	£312
Scotland	£319	£264	£325	£100
Wales	£442	£310	£250	£141

A9. Further monitoring and research into productivity effects is merited. However, given the difficulties of disentangling the numerous factors at play across heterogeneous sites and the lack of robust monitoring, it may be that a small number of short (e.g. one-page) descriptive case studies would serve to illustrate variability in on-the-ground effects and how they could be mitigated.

A10. Readers are invited to suggest suitable case-study sites for consideration, listing:

a. Site location and description
b. Pre-restoration management and condition
c. Restoration timing and activities undertaken
d. Post-restoration management and condition
e. Summary of management adjustments and any perceived opportunity cost, along with any challenges and frustrations experienced

[41] e.g. heather beetle, liver fluke, louping ill

[42] A forthcoming PhD thesis by Guy Freeman of Exeter University is an exception. Results for Exmoor suggest no discernible negative effects and possibly marginal improvements in sward quality.

[43] If labour and fixed costs are subtracted, the Net Margin is lower (sometime negative). However, many land managers use Gross Margins as their measure of profitability.

A11. Three examples are appended below.

Mini case-study: Scottish Borders

The farm is an owner-occupied, mainly sheep holding in southern Scotland. A flock of 1100 mainly Cheviot ewes plus a small herd of sucker cows are run across 90 ha of grassland and 1000 ha of rough grazing. All of the land is within the Less Favoured Area, classed as Severely Disadvantaged. Most feeding requirements are met from the farm's own resources, but around 30% are bought in. A lambing percentage of around 90% is achieved, with the majority of lambs sold as store animals.

Prior to enrolment in an agri-environment restoration scheme, a 25ha parcel of the higher rough grazing peatland area was in a moderately degraded ecological state due to grazing pressure. There was some evidence of localised grazing damage and scattered patches of heather, but bog species were present – including sphagnum hummocks. Agricultural management of the relevant land parcel was not significantly different to other rough grazing parcels, with sheep stocking densities uniformly low across the whole farm, but the sustainable carrying capacity of that parcel was deemed to be lower than average. Enrolment in the agri-environment scheme commenced in 2013 under the Rural Development Programme.

A capital grant was made available for reprofiling, brash covering and fencing-off of a small (0.25ha) area, with the work undertaken by contractors. Obtaining quotes for the work was administratively tedious, as was drafting an acceptable management plan - but otherwise enrolling in the scheme was relatively simple. The parcel of land was judged functionally separate, and hence fencing was not required – only a commitment to more active shepherding to reduce grazing pressure.

Five years on, the general condition of the restored area is recovering with evidence of bog species expanding and the reprofiled haggs have revegetated naturally. No further restoration activities have been required, although the reprofiled area remains fenced-off.

The restoration activity has had no noticeable effect on farm management or productivity. The fenced-off, reprofiled area is trivial in the context of the farm and even the target 25ha area is only a small component of the total area. Moreover, the restored area can still be grazed, but at a slightly lower density than previously. As such, any opportunity costs of restoration have been negligible.

The farmer would consider enrolling further land into restoration (other areas are potentially eligible) but is cautious about entering into further long-term commitments given uncertainty over agricultural policy arrangements post-Brexit.

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Mini case-study: Cairngorms

The farm is a tenanted, specialist sheep holding in north east Scotland. A flock of 480 blackface ewes is run across 10 ha of grassland plus 560 ha of rough grazing. All of the land is within the Less Favoured Area, classed as Severely Disadvantaged. Most feeding requirements are met from the farm's own resources, but around 25% are bought in. A lambing percentage of around 95% is achieved, with all lambs sold as store animals.

Prior to enrolment in an agri-environment restoration scheme, around one-third of the rough grazing area was in a moderately degraded ecological state due to the presence of historical grip drainage. Agricultural management of that land was not significantly different to other rough grazing parcels, with sheep stocking densities uniformly low across the whole farm. However, bog species were present with potential for expansion if rewetting occurred.

Enrolment in the agri-environment scheme commenced in 2014 under the Rural Development Programme. Capital grants were made available for the installation of dams to block grips over a 190ha area, with the work undertaken by contractors. A consultant was used to help with the application process, including drafting the management plan (which included some wider farm adjustments) to secure on-going payments for moorland management.

Four years on, the water table has risen as a result of the grip-blocking and the restored area is noticeably wetter, with isolated open pools of water. No further restoration activities have been required, although the open pools of water may need attention.

The restoration activity has had a noticeable effect on farm management, with the restored area being wetter than previously (although not uniformly so and still grazable). In particular, the open pools of water have reduced access to some areas and, although no deductions to Pillar I payment have yet been made because of them, their presence and eligibility has been discussed.

The wetter conditions have forced lower stocking densities on the restored area, prompting slightly more intensive use of other land. The possibility of over-wintering elsewhere was considered, but instead overall ewe numbers were reduced by around 10%, to avoid having to increase reliance on bought-in feed. However, despite these management changes, the net opportunity costs of restoration are viewed as minimal because the reduction in ewe numbers forced a greater focus on breeding performance and lambing percentages have improved as a result.

Prior to restoration, the farmer had some concerns about possible increased liver fluke risks, but these have been managed through more proactive attention to animal health. Moreover, comparisons with neighbouring (unrestored) farms suggests that any increase in incidence is a general response to wetter conditions rather than restoration per se.

Mini case-study: Keighley

David and his family are farming approximately 1,000 acres in the south Pennines just between Skipton and Keighley. The entire farm is 1,000ft above sea level, with over three quarters of the farm being heather grouse moor. The farm's main income comes from a flock of pedigree Swaledale sheep, with about 750 lambing ewes and 250 replacement hoggs. 550 ewes are kept pure, with the rest crossed with Blue-Faced Leicesters and Texels. The entire farm was in a Higher Level Stewardship Scheme and was being rewarded for maintaining an SSSI (the heather moor). David had also developed some of the pastures for upland wading birds. Due to the extra commitments and bureaucracy associated with new schemes, David has not been able to re-enter an environment scheme. This is an example of how we need to ensure new environmental projects build on existing work and do not act as a barrier.

Running and maintaining an upland and hill farm is a testing but rewarding occupation, for which he hopes he can one day pass on to the next generation. The current change to environmental schemes raises numerous concerns for David, as a tenant farmer on these areas.

Rewetting:

- Changing the land type and surrounding area, causing safety concerns for man and stock.
- Changing the flora and fauna, including increased Bog Asphodel (and other poisonous plants), increased fluke and less productive grass species, causing direct conflicts with agricultural interests.
- Wetting areas adjacent to the target sites, pulling in a lot more than the designated area and further affecting grazing levels.
- Having to remove stock almost entirely from these areas, removing numbers and therefore affecting the business structure.

Environment Schemes:

- Mapping out of and measuring all peatland on the area (upfront capital outlay of thousands of pounds to commission such work).
- Plans to re wet, all 'deep peat'. Regardless of the local hydrology or other elements, frustrating for practitioners who can identify areas where it will not have the desired effect.
- Uncertainty, no commitment to a definition of deep peat. Business runs on a minimum of 3-year cycles, having no confidence in current policy stifles investment and undermines business plans.

Other Concerns:

- Wild Fires: reduced grazing has led to an unmanageable fuel load in some of these areas. In the drier summer months this presents some very real risks to farms, homes and livelihoods.
- Equity: While fully supportive of rejuvenating degraded peatlands, the need to support the active farmer is key. All too often these projects target and reward the landowner, while the additional work and challenges of delivery are passed directly to the tenant, with no financial reward.

Annex B: Environmental public goods and services

B1. Public goods and services are distinguished from private goods and services by being non-excludable and non-rival in consumption. A good which is excludable but not rival, like a sports stadium, is called a 'club' good and can be still be marketed and managed privately. Goods which are rival but non-excludable, like fish in the high seas, can be referred to as open access goods. They can give rise to the 'tragedy of the commons' without management agreements to voluntarily limit access or exploitation. These can be privately negotiated or through government agreements.

B2. Examples of pure public goods include the existence value placed by many people on wild species, the amenity value of landscapes and the systemic value of biodiversity in allowing ecosystem functions, which deliver valued benefits, to persist. This latter value, sometimes referred to as the 'glue' or 'insurance' value of biodiversity is akin to the systemic value in ensuring the global financial system persists through time and why its value is greater than the total value of the financial assets it comprises. Pure public goods will never be directly delivered by the private sector and provide the basic rational for government intervention in ensuring they are delivered.

B3. Most ecosystem services have elements of one or both of these characteristics. Water control, flood moderation and carbon sequestered being examples. The Government can intervene in a number of ways to guarantee supply. It can regulate, it can pay itself for the benefits to be supplied or it can create 'quasi' markets by restricting either the supply or influencing the price associated with the good or service.