Illustrative Economics of Peatland Restoration

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Photo: RSPB

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Summary

As important natural capital, peatlands generate a flow of economically valuable ecosystem services. Running the capital stock down through neglect or degradation reduces these services, impairing the role that peatlands can play in meeting policy objectives such as mitigating climate change, improving water quality and enhancing biodiversity. Although significant information gaps remain, this loss and/or the costs of compensating for it through other means can be significant and costlier than peatland maintenance and restoration.

For example, peatlands can be rich in biodiversity and landscape values which contribute to ecological resilience and rural employment, both of which can suffer if peat is degraded. Equally, degraded peatlands can contribute significant sediment and phosphate loadings into river catchments as well as dissolved organic carbon leading to water discolouration. As evidenced by increasing interest in catchment approaches, reducing such pollution at source through improved land management may be more cost-effective than downstream treatment in certain circumstances: coping with degraded peatlands accounts for a proportion of the £55m/year spent on sediment treatment by the UK water industry.

Similarly, peatlands can act as either a source or a sink of greenhouse gases (GHGs). If degraded, peatlands become net emitters, meaning that achieving emission targets requires additional mitigation effort from other sectors. Currently, official emission reporting mechanisms only recognise actual emission savings achieved through restoration of degraded sites rather than emissions avoided through maintenance of better sites, yet even so the cost-effectiveness (£13/t CO2e) and total abatement potential (2.2.mt mt CO2e/year across 840k ha restored) of restoring degraded peatlands through grip blocking are comparable to some other mitigation activities currently being promoted (see Chart 1 and Table 2). Such restoration is also likely to deliver co-benefits in terms of water quality and biodiversity.

Variation in local conditions and their potential for delivering ecosystem services mean that the economics of altering peatland management will not be uniform. Moreover, estimates of mitigation costs and benefits are imperfectly developed for carbon and even more so for water or biodiversity. As such, illustrative figures presented here could be refined further.

Nevertheless, although better information on the distribution of costs and benefits would be helpful in guiding appropriate targeting, it is likely that a greater emphasis on maintaining and restoring peatland capital is merited by the value of ecosystems services secured.

Chart 1 *Example illustrative GHG mitigation costs and abatement potential*

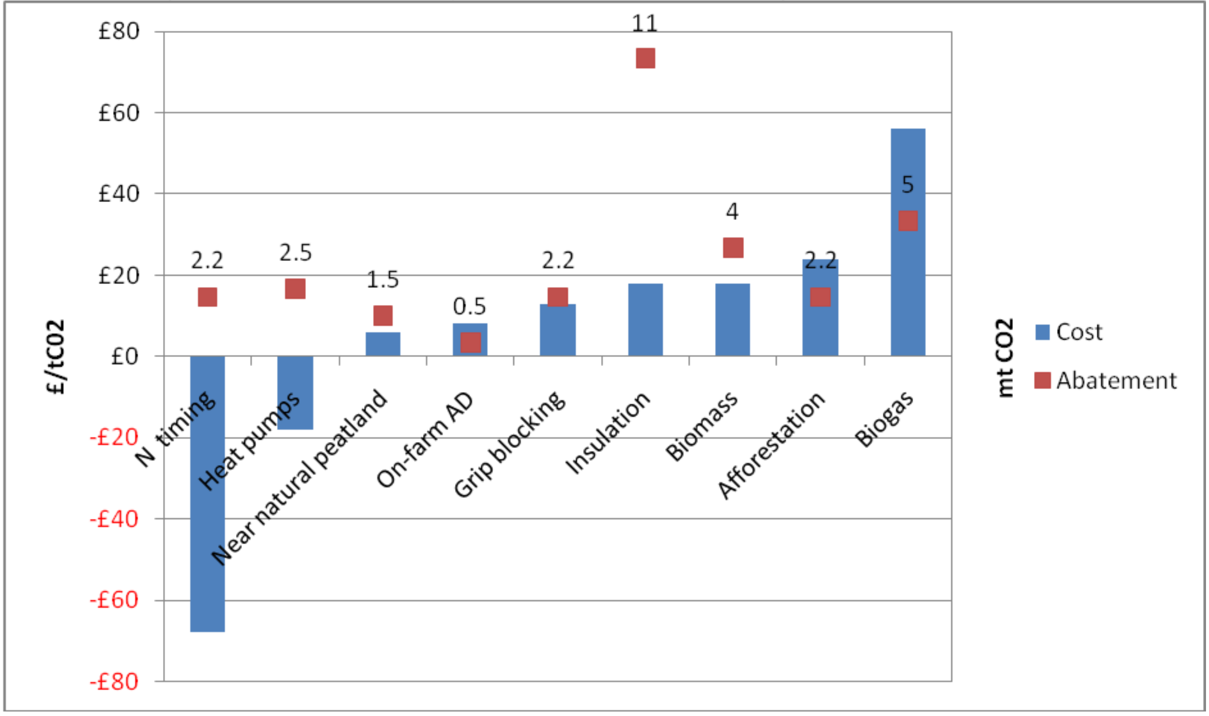

Table 1 *Example emission factors relative to peatland degradation*

Activity	Emission factor	Peatland equivalence
Peatland degradation[1]	3.5 t CO_2e per hectare per year	1 ha
Executive petrol car[2]	274g CO_2e per km	12774 km
Articulated lorry[2]	.980 kg CO_2e per km	3571 km
Electricity consumption[2]	0.54509 kg CO_2e per kWh	6421 kWh

Notes: 1 pers. comm. IUCN; 2 derived from DEFRA/DECC (2010)

Table 2 *Example mitigation activity costs & abatement potential*

Activity	Mitigation cost	Abatement potential per year
N fertiliser timing[2]	-£103 to -£68 per t CO_2e	2.2mt CO_2e
Air source heat pumps[3]	-£18 to £7 per t CO_2e	2.5mt CO_2e
Near natural peatland	£6 per t CO_2e	1.5mt CO_2e
Afforestation sequestration[1]	£0 - £41 per t CO_2e	2.2mt CO_2e
On-farm anaerobic digestion[2]	£1 - £24 per t CO_2e	0.5mt CO_2
Peatland grip blocking	£13 per t CO_2e	2.2mt CO_2e
Domestic building insulation[3]	£18 per t CO_2e	11mt CO_2e
Biomass boilers[3]	£18 per t CO_2e	4 mt CO_2e
Biogas[3]	£56 per t CO_2e	5 mt CO_2e

Notes: derived from: 1 Reed et al. (2009); 2 Moran et al. (2008) & MacLeod et al. (2010); 3 CCC (2010).

1. Introduction

As important natural capital, peatlands are valued for the ecosystem services that they deliver. However, the ability of peatlands to supply particular services varies, with degraded sites typically offering less. Whether such loss is economically justifiable or not depends on whether any benefits derived from degradation outweigh the loss of other services and whether lost services can be secured in other ways. Assessment of such issues is hindered by information gaps and the inherent complexity and variation of ecosystems, but the case of carbon management may serve to illustrate the economics of peatland maintenance and restoration versus degradation.

2. Some illustrative peatland carbon economics

Depending on their condition and management, peatlands can act as either a net sink or a net source of Green House Gases (GHGs). Moreover, the complexity of the processes involved - including both methane and carbon dioxide - and heterogeneity across sites and over time means that these effects are highly variable and subject to some uncertainty (Worrall et al., 2010). Nevertheless, indicative figures can serve to highlight the relative position of peatland management alongside other GHG emission sources and mitigation measures.

A near-natural peat bog may sequester around 0.6 t CO2e per hectare per year.[1] By contrast, a degraded site may emit around 2.9 t CO2e per hectare per year. The difference between a degraded site and a near natural site may thus, for illustrative ease, be around 3.5 t CO2e per hectare per year. This is roughly equivalent to the emissions generated by driving an executive petrol car 13000 km, driving an articulated lorry 3500 km or consuming 6500 kWh of electricity from the National Grid (see Table 1). Currently, official reporting of UK emissions does not recognise losses avoided by preventing degradation only actual reductions achieved through restoration - which are lower at about 2.6 t CO2e per hectare per year.

Table 1 *Example emission factors relative to peatland degradation*

Activity	Emission factor	Peatland equivalence
Peatland degradation[1]	3.5 t CO_2e per hectare per year	1 ha
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As a mitigation measure, restoring a degraded site or maintaining a near natural site avoids some emissions that might otherwise occur plus actively sequesters some additional carbon. Over a 20 year period[2] these savings could amount to around 70 tCO2e per hectare for a near natural site. For a restored site, such as a re-wetted bog, the savings are slightly lower at perhaps 52 tCO2e. The costs of achieving such net emission savings depends on the degree of effort required: restoration may entail upfront investment in, for example, blocking

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[1] As such, on balance, there is a modest net long-term global cooling effect. However, some peatlands have higher methane emissions than others and there is a lot of variation around averages.

[2] The durability of peatlands means that continued savings over a longer time period are likely, but 20 years approximates to the 2030 horizon used in reporting many other mitigation possibilities.

drains, as well as on-going monitoring and maintenance, such as managing vegetation succession, whilst a near natural site might require only a little maintenance.

Median restoration costs are estimated to be around £1500 per hectare (Holden et al., 2008) which, if taken as the net present value[3] of investment and maintenance costs over a 20 year period, equates to a mitigation cost of around £29 per tCO2e. However, although some extremely degraded bare peat sites and some lowland sites requiring land acquisitions can be even costlier, more typical grip blocking restoration may cost nearer to £240/ha which, with assumed on-going maintenance, implies perhaps £13 per tCO2e.[4] For a near natural site, costs would be much lower, perhaps around £6 per tCO2e or less.

Although some mitigation measures, such as improved fertiliser usage in agriculture or domestic air source heat pumps for renewable heat, may be implemented at no cost or even negative cost, £6 to £13 (and even £29) compares favourably with a range of other mitigation measures such as anaerobic digestion, afforestation sequestration and renewable biomass or biogas heat generation (see Table 2 and Chart 1) and is well below the cost-effective threshold of £100 per tCO2e used in devising marginal abatement costs curves for agriculture (MacLeod et al., 2010).

Table 2 *Example mitigation activity costs & abatement potential*

Activity	Mitigation cost	Abatement potential per year
N fertiliser timing[2]	-£103 to -£68 per t CO_2e	2.2mt CO_2e
Air source heat pumps[3]	-£18 to £7 per t CO_2e	2.5mt CO_2e
Near natural peatland	£6 per t CO_2e	1.5mt CO_2e
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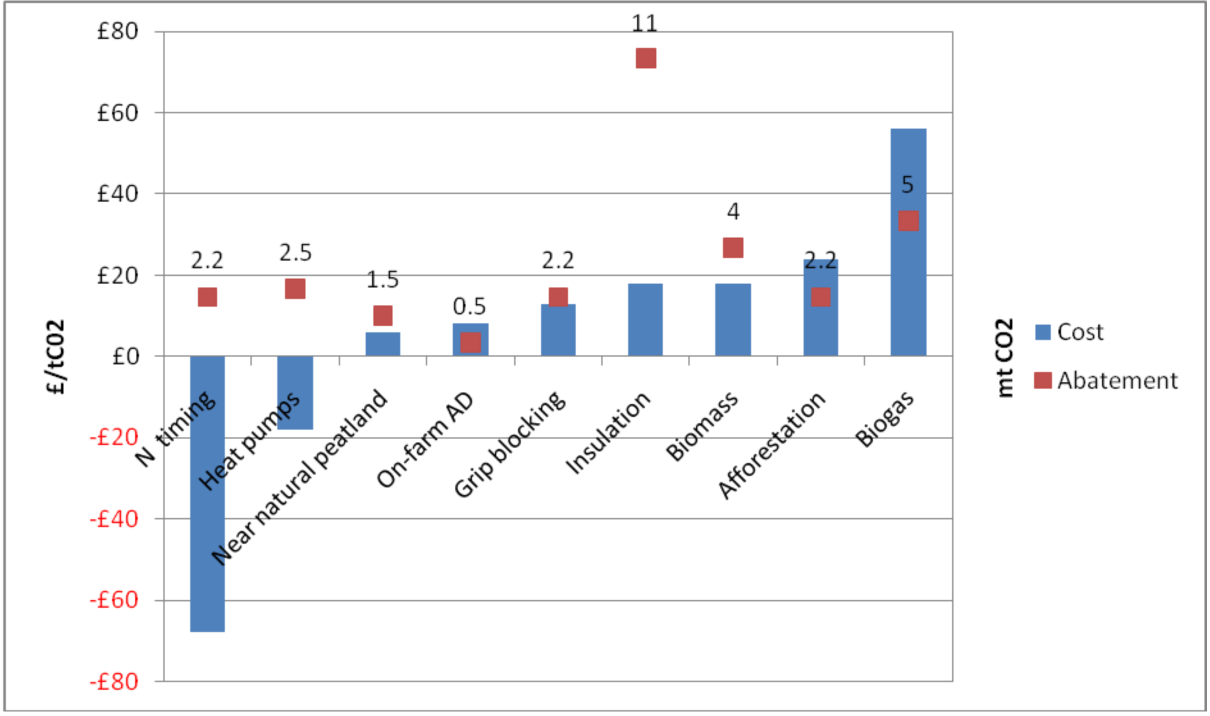
[3] Strictly, because both the costs and benefits of restoration occur over time, the profile of each needs to be known in some detail and an appropriate discount factor applied to convert everything to a comparable (net present value) basis. Moreover costs per hectare can be difficult to estimate since management of a given parcel of land will have some effect on neighbouring parcels too, possibly doubling the area involved. However, given the likely variation of sink and source effects across sites and over time, and in the absence of detailed profile data, simply treating cited costs as net present value figures is a reasonable first approximation for illustrative purposes here.

[4] In the absence of firm data, assuming a simple 30% of median restoration costs would give £450 per ha for limited monitoring and infrequent or minor management spread out over 20 years.

Chart 1 *Example illustrative mitigation costs and abatement potential*



Importantly, whilst active restoration will combat actual emissions the maintenance of sites already in good condition is even more cost-effective since the costs incurred are lower and the total emission savings are higher. However, most of these savings take the form of what might be termed latent emissions that will arise if maintenance falters and a site degrades; of emissions avoided rather than reduced.

This distinction matters since official recording and reporting (such as in the National Inventory) that focuses on curbing actual emissions risks neglecting latent emissions that may be costlier to reduce once realised than if prevented in the first place.[5] It also has a bearing on perceived fairness and perverse incentives if peatland that was previously drained with taxpayer support is then also restored with taxpayer support whilst near natural peatland sites (and their managers) remain unsupported. Nevertheless, re-wetting via grip blocking is still a cost-effective action.

Actual costs at a given site are likely to vary since heterogeneity in local conditions, and thus the potential for restoration and sequestration, can be significant. Moreover, costs arising from restoration and/or maintenance efforts need to be considered alongside possible opportunity costs incurred through altering peatland management and displacing other activities. For example, draining, grazing and burning can enhance agricultural output, the value of which may therefore be reduced through restoration activities.

In many upland areas where agriculture is marginal, the value of forgone commodity outputs will be low or even negative. For example, many upland livestock farming systems are relatively unproductive, are not commercially viable and are sustained through taxpayer support. In such cases, the cost-effectiveness of restoration as a mitigation activity will not be affected significantly by consideration of opportunity costs. Indeed the policy rationale for taxpayer support of upland land management may be enhanced through encompassing GHG mitigation.

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[5] Disregarding latent emissions reduces the abatement potential to be counted, suggesting less of a mitigation role. Yet if sites degrade, emissions become real and thus their mitigation can be counted officially.

By contrast, some lowland agricultural and horticultural activities based on modified peatlands or extracted peat are commercially viable and are less dependent on taxpayer support. In such cases, mitigation activities may displace or at least reduce commodity output levels and thus could incur significant opportunity costs to increase the overall mitigation cost per tCO2e. Moreover, many such sites present more difficult restoration challenges which will incur further costs and/or fewer emission savings. Where such situations arise, restoration may not be cost effective.

This variation in the likely cost-effectiveness of restoration as a mitigation tool highlights the importance of targeted rather than blanket restoration activities (Worrall et al., 2010). Hence, although the total area of degraded peatland could be considered for restoration, a figure such as the UK BAP target of 845,000 ha restored by 2015 may serve as a more reasonable and cost-effective ambition.

Applying the illustrative grip blocking figures presented above to a restoration target of 845,000 ha yields an overall cost of around £580m but an annual emissions abatement potential – relative to allowing degraded sites to remain in poor condition – of around 2.2mt CO2e.[6] If the area of near natural peatland is around 400,000 ha, maintenance of it yields an amount approaching 0.25mt CO2e sequestered plus a further 1.2 mt CO2e of avoided emissions. For comparison, the estimated annual abatement potential of on-farm anaerobic digestion is 0.5mt CO2e whilst that for renewable biomass heat is 4mt CO2e (see Table 2 & Chart 1). The total carbon stock held in the estimated 1.7m to 1.8m hectares of UK peatlands is approximately 10,600m – 12,800m tCO2e (derived from Worrall et al., 2010) whilst annual emissions are estimated to be of the order of 3 mt tCO2e for England alone (Natural England, 2010).[7]

The illustrative figures presented here could be refined further to account for spatial and temporal variation in costs and emission savings and direct comparisons with other mitigation options incur numerous caveats: the analysis is necessarily broad-brush and indicative, not definitive. For example, the emissions associated with near natural, degraded and restored peatland may all be higher or lower than suggested here, not least due to transitional effects between different site conditions. Equally, restoration and maintenance costs may be higher or lower to reflect variation in practical challenges at the local level.

However, the figures presented here have been relatively conservative, erring on the side of higher costs and lower emission savings. For example, notably, the emission figures and target restoration area relate to moor gripped rather than more heavily eroded peatlands with higher emission levels and the likely continuation of savings beyond a 20 year horizon is not considered. Yet they still suggest a mitigation role for restoration and maintenance both in terms of unit cost-effectiveness and aggregate abatement potential for appropriately targeted maintenance and restoration efforts.

Moreover, it is clear that - given binding emission targets - neglecting peatland sink and source effects will throw a greater mitigation burden on other sectors: 3.7mt if degradation extends to near natural sites in good condition; 2.2mt if opportunities for re-wetting via grip blocking are ignored. Current (central) non-traded prices value 2.2mt CO2e saved at around £115m, by 2030 this will have increased to around £150m. Since the value of a capital stock depends on the value of services flowing from it, it is the value of these annual flows of

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[6] Although this would be reduced if implementation/uptake were less than 100% - as applies to published assessment of some other mitigation options.

[7] The National Inventory offers a lower figure of around 1.5mt $CO2_e$, partly because upland peat is excluded. The 3mt figure does not include latent emissions avoided through maintenance and hence is lower than the 3.7mt estimate including them.

emission savings rather than the total stock of carbon held in peatlands that merits policy attention and mechanisms for restoring and maintaining peatlands.

3. Some illustrative peatland water economics

Peatland degradation can also impose treatment costs on the water industry – and thus ultimately on its customers - to address water discolouration and phosphate issues. This may take the form of additional capital investment in equipment but also in terms of the operational and maintenance costs of chemical, labour and energy inputs required in (for example) coagulating, filtering, dewatering and removing sludge to landfill or in mixing water from different sources. Equally, the operating costs and/or frequency of renewal of existing equipment installed to address other contaminants such as Cryptosporidium or nitrates can also be increased. Such costs are difficult disentangle from other treatment costs but are estimated to amount, for all agricultural sediment sources, to £30m for England only (Jacobs, 2008: p154) and in excess of £55m for the UK (Pretty et al., 2000).[8]

Not all of this treatment cost is attributable to peatland sources, but degraded peat is particularly susceptible to wind and water erosion (Towers et al., 2006). Consequently upland catchments are amongst those identified as most at risk of excessive sedimentation and dissolved organic carbon (DOC), with estimated annual loadings commonly in excess of 400kg per hectare (Collins & Anthony, 2008a&b; Cooper et al., 2008).

Hence, although there will be considerable spatial and temporal variation, improved peatland management can potentially reduce treatment costs by reducing pollution at source in some circumstances. For example, restoration of degraded peatland, the use of riparian buffers and peak flow controls may all reduce sediment, DOC and nutrient loadings into a river. The cost-effectiveness of such measures depends on the likely reductions in loadings, the cost of management efforts and the remaining lifespan and capacity of exiting treatment facilities. It will also vary spatially and temporally with, for example, the overall raw quality, volume, turbidity and flashiness or water in different catchments: it is difficult to generalise.

As with GHG emissions, actual costs incurred through altered management activities need to be viewed alongside any opportunity costs arising from (especially) reduced or displaced agricultural activities. Again, as with carbon, this may not be significant in upland catchments but is possibly relevant in more agriculturally productive lowland catchments. However, it is also possible that the off-site benefits of reduced downstream loadings are accompanied by on-site benefits in the form of higher productivity arising from greater retention of topsoil and nutrients (USDA, 2011). That is, rather than incurring opportunity costs there may, in some instances, be local gains too.

Unfortunately, the UK evidence base on the costs and benefits of upstream management relative to downstream treatment is still being assembled[9] and care should be taken to avoid exaggerating the potential gains to be made. Nevertheless, the increasing involvement of some water companies in catchment management activities offers evidence of commercial interest. Hence, although costs and benefits will vary across different catchments and targeting of mitigation efforts will be required, it seems likely that peatland management will offer a cost-effective alternative or complement to water treatment activities in at least some

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[8] Sedimentation may also impose other externality costs on other sectors too. For example, dredging to maintain navigable waterways or lower shellfish yields.

[9] For example, through some of Natural England's ecosystem pilots.

circumstances and could avoid a proportion of the current annual £30m to £55m expended on sediment treatment.

4. Conclusions and some other considerations

The IUCN Peatland Programme has highlighted the condition and vulnerability of UK peatlands by collating and reviewing a range of information on challenges and opportunities. Within this, the policy relevance and economics of carbon, and to a lesser extent water management, are perhaps most developed. That is, notwithstanding some uncertainty over precise figures, official price projections for carbon and ambitious targets for emission reductions plus the advent of the Water Framework Directive and increasing Regulatory approval for catchment management activities involving private water companies all mean that the merits of addressing peatland degradation can be demonstrated in monetary terms – as attempted with the illustrative figures used here. Further refinement of the figures may be possible, but the general message is relatively clear.

However, as a stock of natural capital, peatlands generate a flow of economically valuable ecosystem services that encompass public good aspects beyond simply the externality effects of carbon sequestration/storage and water quality. For example, both upland and lowland peatlands can be rich in biodiversity and landscape values which underpin, directly or indirectly, a variety of commercial activities such as farming and tourism (Littlewood et al., 2010; Reed et al., 2010). Such linkages are not always easy to describe or to ascribe monetary values to, yet do represent economic value (Bateman et al., 2011; Reed et al., 2010)

In many, but not all, cases, desirable aspects of peatlands can be generated jointly. This means that maintenance and restoration motivated primarily by, for example, GHG emission targets may yield additional gains in terms of water quality and biodiveristy. The presence of such ancillary or co-benefits enhances the overall cost-effectiveness of peatland measures. Hence, although better information on the distribution of costs and benefits would be helpful in guiding appropriate targeting, it is likely that a greater emphasis on maintaining and restoring peatland capital is merited by the value of securing delivery of a number of related ecosystems services.

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