EFRA inquiry: State of peatland in England

Written evidence submitted by the Centre for Ecology and Hydrology (PLD0002)

INTRODUCTION

[1] Professor Chris Evans, Dr Amanda Thomson and Dr Ross Morrison are providing evidence to this inquiry on behalf of the Centre for Ecology & Hydrology (CEH).

[2] CEH is a centre of excellence for integrated research into land and freshwater ecosystems and their interaction with the atmosphere. CEH is a Natural Environment Research Council (NERC) research institute, part of UK Research and Innovation (UKRI).

[3] CEH has a leading role in large-scale, long-term monitoring and research on UK peatlands, working in collaboration with other research institutes, higher education organisations, government agencies, private sector and non-governmental organisations. CEH is responsible for the Land-Use, Land-Use Change and Forestry (LULUCF) component of the UK's national greenhouse gas (GHG) emissions inventory, and led the development of methods to include peatlands in the inventory. CEH also operates the majority of the UK's current GHG monitoring stations ('flux towers') on peatland, and has led or is leading several major government-funded peatland research projects, including the £2.5m Defra Lowland Peat programme.

[4] Professor Chris Evans is a biogeochemist and was the lead for the Defra Lowland Peat and BEIS peatland inventory projects, and lead author for the IPCC Wetland Supplement. Dr Amanda Thomson is an ecosystems modeller and is the lead scientist for the LULUCF inventory and Committee on Climate Change assessment of climate mitigation potential from land-use. Dr Ross Morrison is a flux scientist and is the lead for the CEH flux tower network.

EXECUTIVE SUMMARY

[5] The utilisation and degradation of England's peatlands has turned them from a small net sink for CO_2 into a significant source of GHG emissions.

[6] Total present-day greenhouse gas (GHG) emissions from English peatlands are in the region of 10 Mt CO_2e yr^{-1}, which is 3% of total reported English GHG emissions.

[7] The largest sources of English peatland GHG emissions are lowland peatlands that have been drained for arable, horticultural and grassland agriculture (> 80% of total emissions). To date, very little mitigation has been undertaken in these areas, due to their high agricultural productivity and economic value.

[8] Most of the remaining GHG emissions from English peats derive from upland blanket bog, and are the result of land-use practices including moorland drainage, burning, grazing and conifer afforestation. Large-scale re-wetting and restoration of drained blanket bog has reduced emissions, but burning and plantation forestry remain widespread.

[9] There is strong evidence that raising water levels in agriculturally drained lowland peatlands could make a major contribution to climate change mitigation, but this needs to be reconciled with the need to maintain food production and support rural economies. Ongoing work for Defra is examining the trade-offs and opportunities involved in raising water levels within peatlands remaining under agricultural management.

[10] If the UK is to achieve its target of net zero greenhouse gas emissions, it will be necessary to take further steps to re-wet peatlands.

EVIDENCE

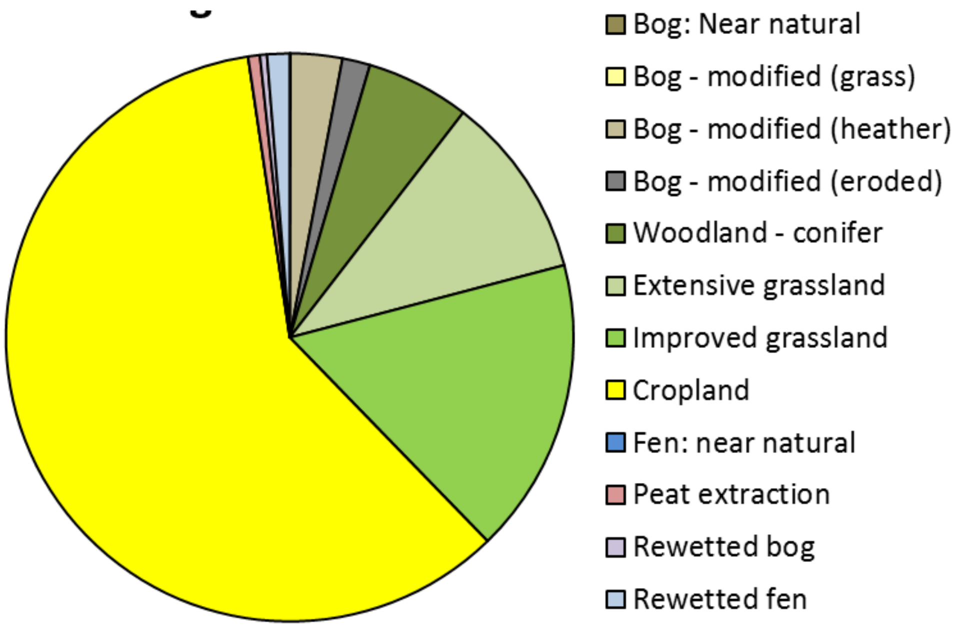
[11] Globally, peatlands emit around 1.2 to 1.9 Gt of CO_{2e} to the atmosphere each year[1,2]. This represents 2-4% of all anthropogenic GHG emissions, and 20-30% of emissions from the Agriculture, Forestry and Other Land Use sector[3].

Q1. What is the current state of peatlands in England, and how is it changing?

[12] The 2013 IPCC Wetland Supplement[4] provides a robust framework for reporting GHG emissions from managed peatlands to the UN Framework Convention on Climate Change. The CEH-led BEIS Peatland Inventory project[5] implemented the IPCC methodology for UK peatlands, based on the best currently available UK peat condition data and country-specific ('Tier 2') emissions factors. We estimated that the UK's peatlands a whole are emitting 23.2 Mt CO_2e yr^{-1}, which equates to 5% of reported total GHG emissions for the UK for 2017. The contribution of England's peatlands to this total is estimated at 10.9 Mt CO_2e yr^{-1} (3% of reported total GHG emissions for England for 2017).

[13] There are multiple causes of peatland GHG emission, extending from upland blanket bogs (such as the Pennines and Dartmoor) to lowland raised bogs (such as the Manchester Mosses) and fens (such as the East Anglian Fens and Somerset Levels). In England, the largest sources of GHG emissions, calculated for the BEIS Peatland Inventory project[5], are believed to be lowland peatlands drained for intensive arable and horticulture (6.5 Mt CO_2e yr^{-1}, 60% of the total – see Figure 1), and for grassland agriculture (3.0 Mt CO_2e yr^{-1}, 27% of the total). Peat that has been drained for forestry in England emits an estimated 0.6 Mt CO_2e yr^{-1} (6% of the total). Upland blanket bogs are affected by a range of pressures including drainage, grazing, prescribed burning on grouse moors, and erosion; in combination, these pressures lead to an estimated present-day emission of 0.5 Mt CO_2e yr^{-1} (5% of total emissions from English peats). Horticultural peat extraction contributes 0.005 Mt CO_2e yr^{-1} of emissions via the *in situ* decomposition of peat, however the oxidation of extracted peat used by the horticulture sector and gardeners contributes a further 0.3 Mt CO_2e yr^{-1} of emissions[6].

Figure 1. *Proportional contribution of different land-use activities to total estimated greenhouse gas emissions from English peatlands.*



[14] Between 1990 (the emissions inventory baseline year) and 2013 (the most recent year for which emissions have been calculated to date), we estimate that approximately 45,000 ha of English peatland were re-wetted as part of restoration projects[5,7], leading to emissions reductions of approximately 0.3 Mt CO_2e yr^{-1}. Restoration projects were overwhelmingly focused on upland blanket bog, and most occurred within the last 5-10 years of the assessment. However, a considerable number of additional restoration and re-wetting projects have occurred since 2013, so total emissions reductions should now be larger. Nevertheless, it is clear that GHG emissions reductions from peatlands have not kept pace with emissions reductions in other sectors, and will not do so in future unless emissions from agriculturally drained lowland peat are addressed.

Q2) What is the potential contribution of peatland restoration to the UK's net zero greenhouse gas target, and the consequence of inaction?

[15] Healthy peatlands can sequester CO_2 over millennia, thereby exerting a cooling effect on the climate. Rates of CO_2 uptake by healthy peatlands are around 2-4 t CO_2 ha^{-1} yr^{-1}, and this is partly offset by naturally high rates of methane (CH_4) emission, a stronger greenhouse gas[4,5]. This compares to CO_2 emissions from agriculturally drained peatlands of around 24 t CO_2 ha^{-1} yr^{-1}. Consequently, the potential to offset fossil fuel emissions of CO_2 through 'negative

emissions' by peatlands is modest, whereas the potential to directly mitigate climate change by 'avoided emissions' from peatlands is large.

[16] In the absence of re-wetting, drained peatlands will ultimately be lost to oxidation – this is already well advanced in parts of England that were drained centuries ago. In addition to high CO_2 emissions, this is causing ongoing land subsidence (around 1 cm yr^{-1}) which leads to a requirement for energy-intensive and expensive pumped drainage, increases flood risk to land that is now below river and sea-level, and causes damage to linear infrastructure such as roads and power lines. The eventual loss of peat soils also leads to a reduction in agricultural and economic productivity.

Q3) What are the economic, ecological and cultural benefits of restoring and maintaining peatlands?

[17] The carbon balance of a peatland, and its associated capacity to emit or sequester CO_2, are intrinsically linked to other ecosystem functions of peat. A healthy, growing peatland will support specialist wetland plants such as *Sphagnum* mosses, and will have greater capacity to attenuate runoff (with some potential to reduce downstream flood risk). A upland blanket bog that has been degraded by drainage, burning, over-grazing or air pollution will be susceptible to erosion, faster runoff of water (with associated increases in downstream flood risk), and increased transport of dissolved and particulate carbon into watercourses and reservoirs (leading to increased water treatment costs)[8-9].

[18] Lowland peats that have been drained for agriculture are susceptible to ground subsidence (leading to increased pumping costs and damage to infrastructure such as roads and power lines) and wind erosion which, together with subsidence and peat oxidation, will ultimately lead to the loss of peat soils and declining agricultural productivity. Maintaining higher water levels in cultivated lowland peats is likely to reduce subsidence and associated infrastructure costs, avoid further increases in pumping costs, and extend the lifetime of the peat. However, this is likely to require either adaptations or trade-offs with regard to agricultural production.

[19] Natural, *Sphagnum*-dominated peatlands are intrinsically resistant to wildfire. There is no reliable evidence to indicate that natural bogs benefit from managed burning with regard to either their carbon balance or their resilience to wildfire. The high vulnerability of Pennine blanket bogs to wildfire can be attributed to their historic degradation by land-use and air

pollution (which reduce protective *Sphagnum* cover), as well as the active management of grouse moors to increase cover of woody heather biomass[10].

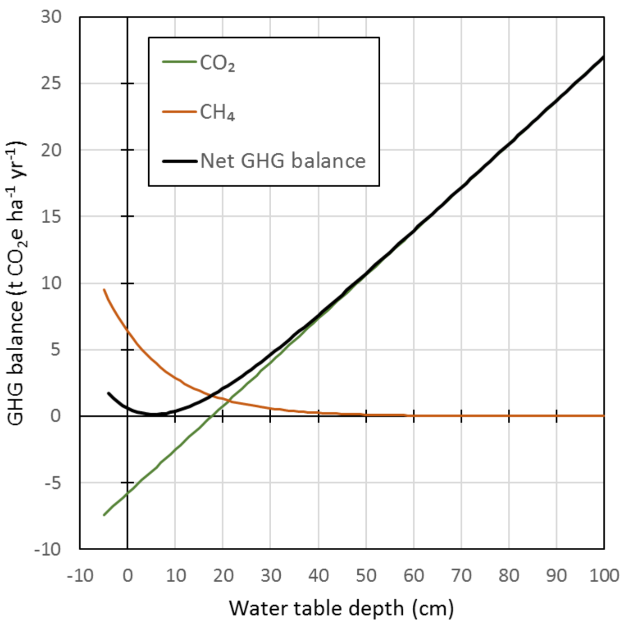
[20] A peatland with a high water table and natural peat-forming vegetation cover will be resilient to climate changes and extremes, whereas a degraded peatland with low water tables, modified (non-peat forming) vegetation and continued land-use pressures will not. Restoration, re-wetting and land-use mitigation will therefore help to protect England's peatlands from future climate change.

Q5) What should be included in the forthcoming England Peatland Strategy?

[21] The strategy should focus on raising water levels in both semi-natural and agricultural peatlands. There is strong evidence that the depth of the water table in peatlands is of overriding importance in determining its carbon and GHG balance. A collation of UK and international measurements made using the state-of-the-art 'flux tower' method (Figure 2[11,12]) indicates that for every 10 cm that water tables are raised towards the surface, CO_2 emissions will be reduced by over 3 t CO_2 ha^{-1} yr^{-1}. This reduction in GHG emissions will only be offset by higher methane emissions if water levels are raised above the peat surface. Note that lowering of water levels in peatlands can occur either directly as a result of drainage activities, or indirectly as a result of peat degradation (e.g. gully erosion) or vegetation changes (e.g. tree planting, increased heather cover due to grouse moor management).

[22] Overall, we estimate that halving average drainage depths across the 433,000 ha of peat under intensive agricultural use in the UK (most of which is in England) could reduce their emissions by around 70%. This would not necessarily preclude the continued agricultural utilisation of these areas, which in many areas (notably the East Anglian Fens) comprise high-grade agricultural land, and make a major contribution to UK food production and the rural economy, although changes in crop type and management practices would be required. CEH are leading a current project for Defra to examine the trade-offs and opportunities involved in raising water levels within arable/horticultural peatlands.

Figure 2. *Observed relationships between carbon dioxide (CO_2), methane (CH_4) and their combined climate impact (net GHG balance) based on 38 UK and international CO_2 flux tower studies, and 37 UK and Irish studies of CH_4 fluxes[12]. The net GHG balance is based on the IPCC's 100-year global warming potential (GWP) for CH_4 of 28, i.e. assuming that CH_4 is 28 times more powerful as a greenhouse gas than CO_2. Note that the optimal GHG balance of a peatland occurs when water tables are within 0-10 cm of the ground surface.*



[23] The England Peat Strategy should be underpinned by a robust, long-term scientific evidence base. Although the UK's peatland research is relatively strong, and has been supported by a range of government funding, it lacks coordination, integration or secure long-term funding for key monitoring and experiments. Good spatial data on UK peatland condition are also lacking, although recent work suggests that greater use of freely available European Sentinel satellite data could address this problem[13]. Greater integration of Research Council funding for basic mechanistic science, and government funding for applied policy-oriented science, would ensure that the UK retains a strong evidence base to support policy decisions, and world leadership in developing solutions to a major global challenge.

RECOMMENDATIONS

1) Managed and degraded peatlands are a major contributor to the UK's total GHG emissions (~4%) and should therefore be fully included in the national emissions inventory.

2) Achieving 'net zero' GHG emissions will likely require fundamental changes in UK peatland management.

3) We recommend that both upland and lowland peatlands are included in the England Peatland Strategy, and that the particular characteristics, challenges and opportunities of each are taken into account.

4) In upland blanket bogs that have been impacted by drainage, grazing, burning and afforestation, full restoration to wetland may be practically and economically viable if agricultural payments are directed towards a broader set of 'public goods', rather than area- or production-based subsidy schemes.

5) In lowland peatlands under agricultural management, large-scale restoration to wetland is unlikely to be economically viable or societally acceptable in the short-term, and would significantly impact on UK food production. In these areas, we recommend that continued policy attention be given to the development of effective management options that would reconcile their ongoing agricultural use with the need to reduce their contribution to GHG emissions and extend their agricultural lifetime.

6) The UK's world-leading scientific evidence base on peatlands would benefit from coordinated long-term support from Defra, BEIS, the devolved administrations and UKRI, with the express aims of supporting sustainable peatland management, national emissions inventory reporting and the net-zero emissions target.

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