

## SPICe Briefing

# Peatlands and Climate Change

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Sundew, source: Norrie Russell

Peatlands are one of Scotland's most important natural assets in terms of the ecosystem services they provide. They have the potential to play a role in climate change mitigation : in general terms, healthy peatlands act as a sink for greenhouse gases, while degraded peatlands can act as a large source of carbon dioxide. Scottish peatlands also support biodiversity of internationally recognised significance; are important for climate change adaptation; water quality and flow; and are culturally valuable. This briefing describes the ecosystems services provided by peatlands in Scotland, with particular emphasis on their importance for climate change mitigation.



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## EXECUTIVE SUMMARY

Peat is a type of soil that contains predominantly dead organic matter. It forms under water-logged conditions from dead plant material and accumulates where rainfall is high and loss of water through evapotranspiration is low. Scottish peatlands are predominantly blanket bogs, the largest of which are found in the Highlands and Western Isles. Raised bogs are mostly confined to the Central Belt and Grampian Plain (see Box 1 for terminology explanations). Scotland has about 60% of the UK's peatlands, and 4% of Europe's total peat carbon store. Today around 20% of Scotland's land area is covered by blanket bogs alone, comprising about 15% of the global total for this habitat.

Scottish peats are estimated to hold around 1,620 Mt of Carbon. Maintaining peatlands in good condition can reduce net carbon emissions as peatlands can sequester further carbon. Degraded peatlands, however, release their stored carbon as exposed peat decomposes. Peatlands are also important for their unique biodiversity. Scottish peatlands support many species of European importance. Blanket bog itself is a protected habitat and Scotland has a target to ensure around 600,000 hectares are in good condition by 2015. Peatlands play an important role in upland water systems, and help maintain the quality and supply of freshwater. 70% of drinking water supplies come from upland catchment areas in the UK. Peatlands are also important for their cultural and archaeological value.

Peatlands can be damaged through a range of land management practices such as draining, burning, overgrazing, pollution, afforestation, extraction, establishment of windfarms and access paths. Damage can range from a slow lowering of water levels which might not have an obvious effect for many years, to complete removal of the vegetative layer with bare peat subject to severe erosion.

The restoration of peatlands aims to re-establish peatland function and associated ecosystem services and secure the storage of carbon already held within the peat. It can also help peatlands adapt to climate change.

Peatlands are currently attracting policy interest because of their potential to provide the ecosystem services described above, particularly their potential role in climate change mitigation. The [IUCN UK Peatland Programme](#) and Commission of Inquiry on Peatlands based in Scotland has been instrumental in drawing together much information and focusing attention on the benefits that peatlands in good condition can provide. Scottish Government supports peatland restoration for the carbon and biodiversity benefits it can provide. The Scottish Parliament has debated investing in the future of Scotland's peatlands and the Rural Affairs Environment and Climate Change Committee is holding evidence sessions on peatlands.

On the international level, it was agreed at the 2011 Durban climate conference that rewetting of wetlands (including peatlands) can be included in the Kyoto Protocol's accounting of greenhouse gas emissions. The Intergovernmental Panel on Climate Change (IPCC) is working on a methodology to account for wetland restoration. The reform of the European Common Agricultural Policy is also being described as an opportunity to better link the carbon emissions or sinks provided by land use to support received by land managers (see [Annex 2](#) more on policy drivers).

### **Box 1: Useful Terminology**

**Peat** – a soil made of dead organic material that has been formed in situ and under waterlogged conditions.

**Peatland** - an area with a naturally accumulated peat layer at the surface.

**Mire** - a peatland where peat is currently formed and accumulating.

**Bog** - a peatland that receives water just from rain/snow falling on its surface.

**Blanket bogs** - bogs developed over large areas of ground hollows or undulating ground, where rainfall is high and evapotranspiration is low.

**Raised bogs** - dome-shaped bogs that have developed over former loch or lake basins.

**Fen** - a peatland that receives water and nutrients from soil/rock/groundwater in addition to precipitation.

**Grip** – man-made surface drainage ditches in a peatland.

**Muirburn** – prescribed burning of old growth of heather to encourage new growth.

**Sphagnum** – a group of species of moss prevalent on peat bogs.

**Evapotranspiration** – the sum of evaporation (water loss from the ground surface) and transpiration (water loss from plants).

**Greenhouse Gases** – gases which absorb and emit infrared radiation in the atmosphere. The main greenhouse gases are water vapour (H<sub>2</sub>O), carbon dioxide (CO<sub>2</sub>), methane (CH<sub>4</sub>), nitrous oxide (N<sub>2</sub>O) and ozone (O<sub>3</sub>).

**SO<sub>2</sub>** - Sulphur dioxide - gas, released from burning fossil fuels like coal and oil. One of the main chemicals that cause acid rain.

**Organic matter** – matter from once living organisms which is capable of decay.

**Carbon** – one of the most abundant chemical elements, present in all known life forms. Carbon is mainly stored in soil as soil organic carbon.

**tCO<sub>2</sub>e** - tonnes carbon dioxide equivalent - describes, for a given mixture and amount of greenhouse gas, the amount of CO<sub>2</sub> that would have the same global warming potential (GWP), when measured over a specified timescale.

**LULUCF** – Land Use, Land-Use Change and Forestry (LULUCF) – a category under which emissions can be reported under the Kyoto Protocol.

**Ecosystem services** - the benefits provided by ecosystems that contribute to making human life both possible and worth living.

**IPCC** - Intergovernmental Panel on Climate Change – the international body assessing the scientific, technical and socio-economic information relevant for the understanding of the risk of human-induced climate change.

**BAP** - Biodiversity Action Plan - action plans for the most threatened species and habitats to aid recovery.

## INTRODUCTION TO PEATLANDS

Peat is a type of soil that contains predominantly organic matter. It forms under water-logged conditions from dead plant material and accumulates where rainfall is high and loss of water through evapotranspiration is low (Bain *et al.* 2011). Scottish peatlands are predominantly blanket bogs (see Box 1), the largest of which are found in the Highlands and Western Isles. Raised bogs are mostly confined to the Central Belt and Grampian Plain. In Scotland, peat is defined as a soil class with a surface layer greater than half a metre thick and composed of more than 60% organic matter (Scottish Government 2010a). Shallower peaty soils also store carbon and are more widely spread across Scotland.

## PEAT FORMATION

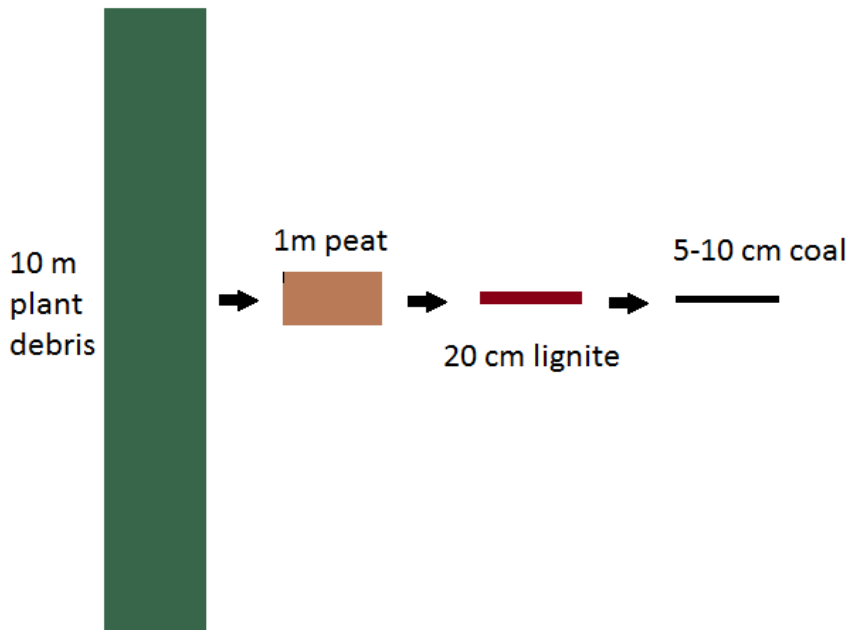
When vegetation dies back, it usually decomposes. This process is relatively rapid in the presence of fungi and bacteria that require oxygen to survive, and allows the plant matter to break down into water and carbon dioxide. In peatlands, where the water table is generally close to the surface all year round, dead vegetation accumulates underwater and lack of oxygen slows down decomposition. The resultant organic substance (peat) from this incomplete process contains much of the carbon from the original vegetation. Peat forms from a range of plant matter including mosses, reeds, grasses, shrubs and trees. In the UK, *Sphagnum* mosses (see Box 2) are one of the most important building blocks of peat.

living moss	Matrix of living plants (often <i>Sphagnum</i> ) and recently deposited dead material. Peat formed and carbon sequestered in this layer.
acrotelm	
catotelm	Peat deposited here from the acrotelm throughout the lifetime of the peatland. Permanently waterlogged and oxygen-starved, so that decomposition is about a thousand times slower than in the acrotelm.

**Figure 1:** Layered structure of peat-forming bogs.

## PEAT IN THE GEOLOGICAL RECORD

Peat formation is the first stage in the process by which coal forms from vegetation. The second stage of this process is vertical compression of peat layers under later sediments to form lignite. Over millions of years, further compression leads to the production of first Bituminous coal and then, when both temperature and pressure are high, anthracite.



**Figure 2:** Relative thicknesses of different stages of coal formation. Decomposing plant matter reduces in thickness by a factor of about 10 during the accumulation of peat.

## PEAT AND GREENHOUSE GASES

Peatlands are important for greenhouse gas budgets because:

- 1) They store carbon in historically accumulated peat and this carbon can potentially be lost if peat is allowed to burn or decompose.
- 2) The active fluxes of greenhouse gas during peat formation mean they can potentially sequester further carbon.

The fluxes of greenhouse gases in and out of healthy, active peatlands are complex. Where peat is accumulating, carbon drawn from the atmosphere during photosynthesis is sequestered. Anaerobic decay deeper in the peat results in the release of methane, a much more potent but shorter lived greenhouse gas, into the atmosphere. Peatlands can lose carbon through the flow of water, which removes dissolved and particulate organic carbon as well as dissolved carbon gases. When material passes to the lower layer (catotelm), decay becomes extremely slow and carbon is sequestered (Lindsay 2010). The ratio between decay and preservation depends on the type of vegetation present, as *Sphagnum* mosses are much more resistant to decay than plants such as grasses or sedges. There may also be nitrous oxide fluxes associated with some peatland types. These are not well studied: in the few cases where they have been measured they have been found to be negligible unless a peatland has been fertilised with nitrogen or the atmospheric N deposition is high (Artz *et al.* 2012).

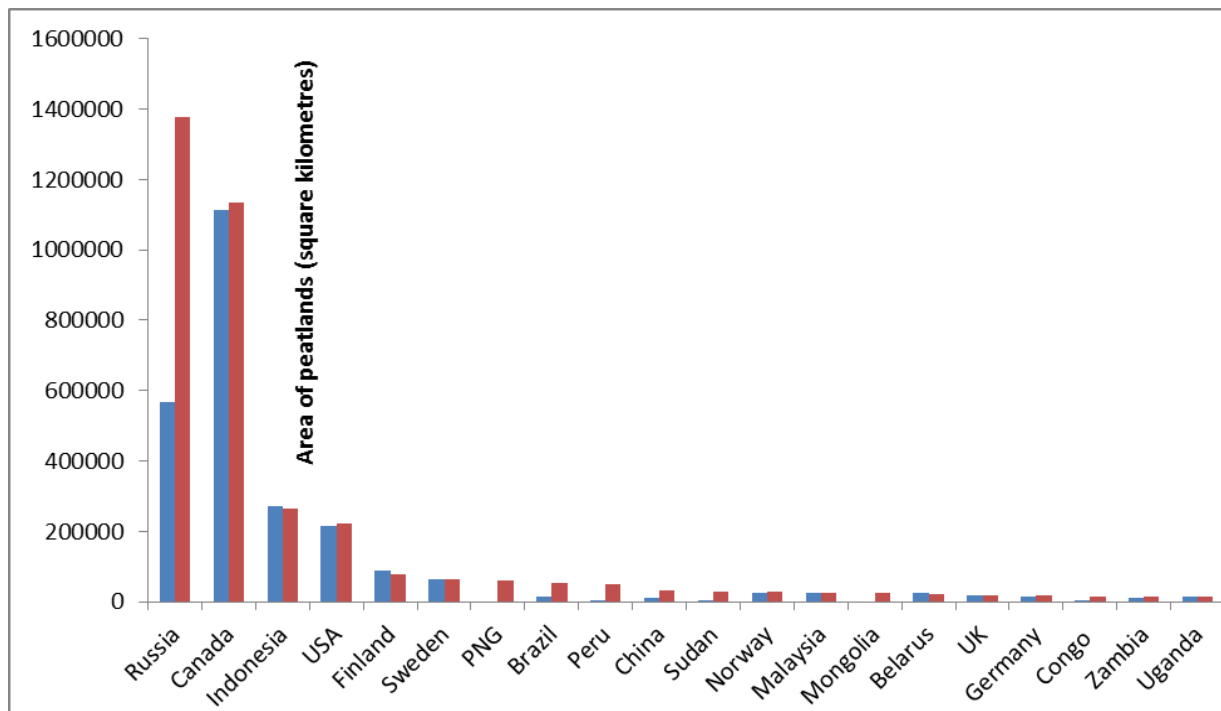
The relative importance of all these processes will control whether the net flux of greenhouse gases from the peatland is to, or from, the atmosphere. This depends on factors including water table height, type of vegetation and degree of alteration of the peatland or restored peatland (Worrall *et al.* 2011). Healthy peatlands are likely to be a net greenhouse gas accumulator. Degraded peatlands, where peat is exposed to the air, lose CO<sub>2</sub> very quickly as organic material is eroded and oxidised and are likely to be a net emitter.



## GLOBAL DISTRIBUTION

Peatlands covers around of 3% of the world's land area, and take many different forms from the tropics to circumpolar regions. These include freshwater bogs and mires, cryosols<sup>1</sup> (mostly in the Arctic and Sub-arctic), mangroves and salt marshes, cloud forests, paddies and paludified forests<sup>2</sup> (Joosten *et al.* 2010). Peat may also form in permanently wet grassy valleys ('dambos') or at altitudes above the tree-line in the tropics ('paramos'). In the tropics most peat is formed from trees while at high latitudes in Canada and northern Europe, it is mostly formed from mosses (Parish *et al.* 2008). Most of the world's peat is found in northern Russia and Canada, followed by Indonesia, the USA and northern Europe. The Falkland Islands have the highest percentage area covered by peatland (94%) of any country (Joosten *et al.* 2010).

## MEASUREMENT OF PEAT COVERAGE



**Figure 3:** The 20 countries in the world with the largest areas of peatlands according to Joosten *et al.*, 2010 (Red) and the World Energy Council, 2007 (Blue). The World Energy Council Report (2007) estimates are based on a compilation of peat resources from 1996 and World Energy Council member committee reports. A more recent review (Joosten 2010) takes detailed country by country information available in the International Mire Conservation Group Global Peatland Database. Both studies define peatlands as having a minimum peat depth of 30 cm on undrained land. There is a broad agreement between the two sources, with the most significant discrepancies being in values for Russia, Papua New Guinea and Mongolia. The UK estimates used by these studies are lower than the most recent figures. (see below) The new figures suggest that the UK could be in the top 12 countries in the world in terms of its area of peatland.

Global peat inventories are still by no means comprehensive, with many countries having only a limited idea of the amount of their peat resources (Joosten *et al.* 2010). This is largely due to the difficulty in identifying the presence of peat using satellite technology. On a regional scale, where the relationship between vegetation cover observable by satellite and the presence of peat can be determined by verification on the ground, satellite or aerial measurements can be

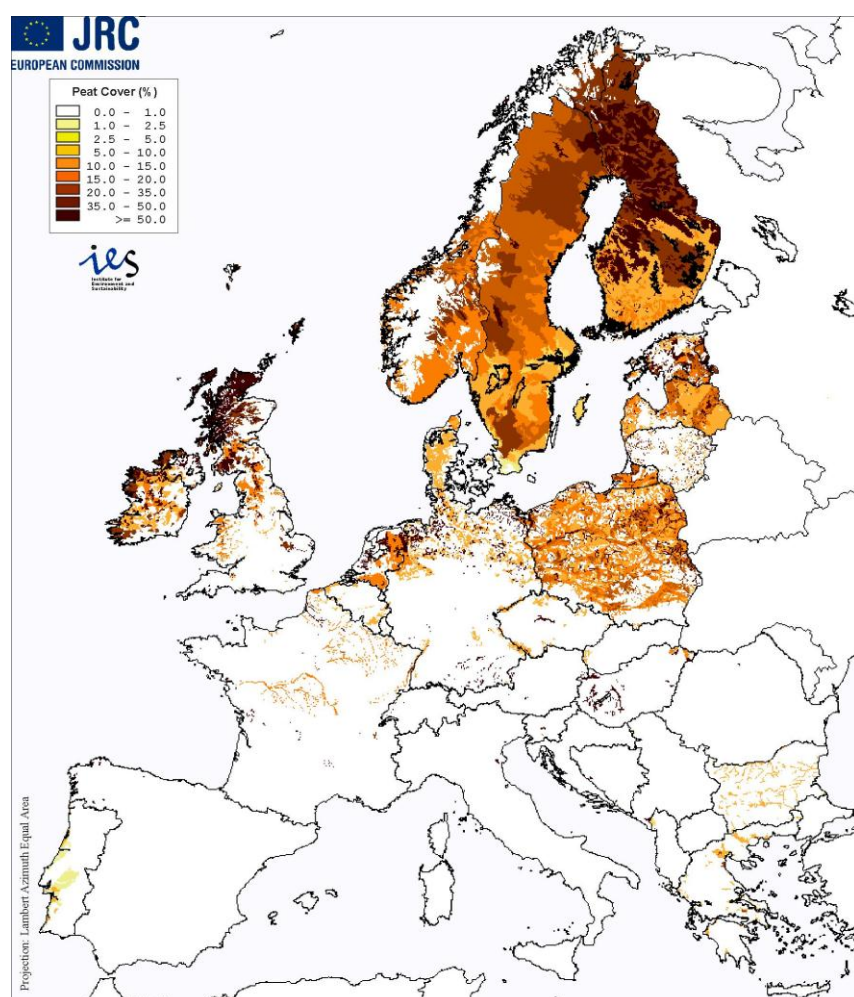
<sup>1</sup> Cryosols are perennially frozen soils occurring in the permafrost zones in the Arctic, Antarctic and some alpine zones.

<sup>2</sup> Where a layer of peat has developed over forests soils without a fully aquatic phase, but tree roots still extend down to mineral soil below.

used to map peatlands. However, determination of peat thickness and therefore the amount of sequestered carbon cannot be determined using current satellite techniques. Most global inventories therefore depend on compilations of field studies. As the way peatland is defined and uncertainties calculated vary from study to study, and completeness of coverage will vary between countries, global comparison of carbon stocks can be complicated. This is illustrated in Figure 2 by the comparison of two global inventories of peat stocks (World Energy Council 2007 and Joosten 2010).

## EUROPEAN DISTRIBUTION

The extent and distribution of peatlands in Europe have been estimated from soil databases and topsoil compositions (Montanarella *et al.* 2006). The European Union has approximately 515,000 km<sup>2</sup> of peatlands, with the most extensive deposits in Scandinavia, Scotland and Ireland. As can be seen from the map, the Northwest of Scotland has the highest percentage cover of peatlands of anywhere in Europe.



**Figure 4:** Peatland distributions across Europe from Montanarella *et al.* (2006). Percentage Peat cover indicates the percentage of ground covered by either peat or peat-topped soils.

## UK DISTRIBUTION

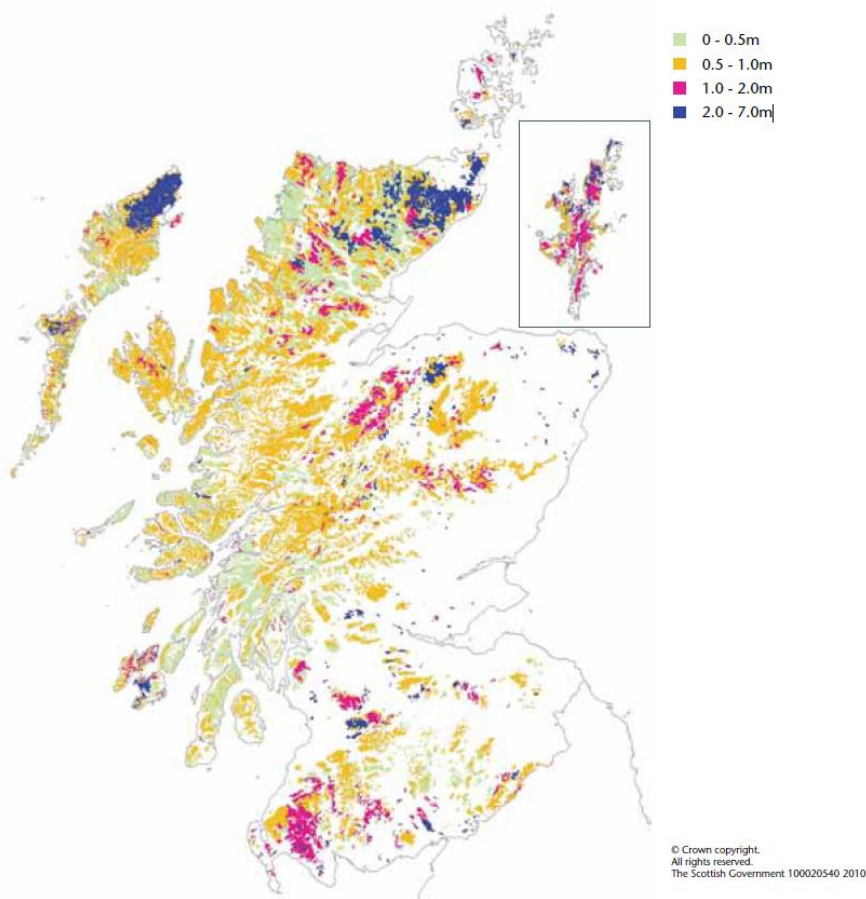
The formation of bogs in the UK began 10,000 years ago at the end of the last ice age, when glaciers retreated northwards, leaving behind a landscape of shallow meltwater lakes and



waterlogged hollows. An estimated 2.3 million hectares<sup>3</sup> (9.5% of the UK land area) is covered by bog peatlands (JNCC 2011). Sources of information about the extent and characteristics of peatland in the UK include national surveys (normally conducted to map UK resources), maps of soil, vegetation and geology and data from research/environmental monitoring sites. Although there is broad agreement on what constitutes a peatland, the Joint Nature Conservation Committee report into the state of the UK's peatlands concluded that there is "little convergence" in methods used to describe the character and extent of peatlands within the UK and that "we need better coordinated and consistent information gathering fit to allow new understanding on the function of peatlands" (JNCC 2011).

## SCOTLAND DISTRIBUTION

Scotland has about 60% of the UK's peatlands, and 4% of Europe's total peat carbon store (UKCCC 2011). Today around 1.8 million hectares<sup>4</sup> (over 20% of Scotland's land area) is covered by blanket bogs alone (JNCC 2011), comprising about 15% of the global total for this habitat (Scottish Government 2010a). Blanket bogs are rare on a global scale, and those in Caithness and Sutherland are some of the largest and most intact in the world today (JNCC 2011).



**Figure 5:** Map of peat depth across Scotland. Source Hutton Institute in Scottish Government (2010a)

<sup>3</sup> Measurements of the total extent vary depending on definitions used. This figure is the total measurement for UK BAP bog habitat. However, if soil map data (which includes peatlands converted to forestry or agriculture) is used, the total is much higher – 3.3 million hectares according to JNCC (2011).

<sup>4</sup> Again, totals vary depending on methods used. The JNCC figure is the extent of blanket bog BAP habitat. Artz *et al.* (in review) give a range between 1.65 – 2.1 million hectares.

## SERVICES PROVIDED BY SCOTTISH PEATLANDS

The UK National Ecosystem Assessment (NEA) defines ecosystem services as “the benefits provided by ecosystems that contribute to making human life both possible and worth living”. Services can be divided as follows: provisioning services (direct products); regulating services (regulation of ecosystem processes); supporting services (supporting production of other services); and cultural services (non-material benefits). This section describes some of the benefits provided by peatlands and the policies that affect them. A fuller list of the ecosystem services provided by peatlands according to the UK NEA is included in [Annex 1](#). Policies relating to peatlands are listed in [Annex 2](#).

## CLIMATE REGULATION

As described earlier, peatlands store significant amounts of carbon: despite covering only 3% of the world’s land area, they contain nearly 30% of all carbon stored on land, (estimated at 550Gt) (Parish *et al.* 2008). The carbon held in Scottish peats has been estimated at around 1,620 ± 70Mt (Smith *et al.* 2009). If emitted as CO<sub>2</sub>, this would be more than 100 greater than Scotland’s annual emissions<sup>5</sup>.

Peatlands can act as a source or sink of carbon depending on their condition. Peatlands that are cultivated for agriculture can release as much as 24 tCO<sub>2</sub>e per hectare per year. Peatlands in good condition however retain their stored carbon and can sequester around 0.7 to 2.8 additional tCO<sub>2</sub>e per hectare per year (Artz *et al.* 2011).

## BIODIVERSITY

Scottish peatlands support nationally and internationally important biodiversity. Some peatland plant communities found in the United Kingdom are globally rare. They also make up the largest continuous blocks of semi-natural habitat in the UK (Littlewood *et al.* 2010). Blanket bog is protected under the EC Habitats Directive Annex I and is included in the UK Biodiversity Action Plan (UK BAP) as a Priority Habitat.

Peatlands provide important habitat for highly specialised species, adapted to surviving in acidic, low-nutrient, waterlogged environments. Key plant species include *Sphagnum* mosses (Box 2) and cottongrass, sometimes associated with cranberry, bog rosemary and cloudberry. Peatlands are also important for bird species of European importance such as golden plover, dunlin, hen harrier and golden eagle. They also support newts, frogs, adders; and spiders (3 species are found only on blanket bog), dragonflies and damselflies.

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<sup>5</sup> Tonnes of carbon are converted to tCO<sub>2</sub>e by multiplying by the ratios of molecular weights which works out at 3.67. In 2009, Scotland’s emissions were 51 Mt CO<sub>2</sub>e compared to around 6000 Mt CO<sub>2</sub>e stored in peat.

## **BOX 2: *Sphagnum* Mosses - the building blocks of British peatlands**



Source: Norrie Russell

*Sphagnum* mosses are the main peat-forming species in Scottish bogs, and therefore the plants contributing most to carbon sequestration. *Sphagnum* species increase the acidity of water in the upper layers of peatlands and contribute to peat formation. They also play a crucial role in the carbon flux of mires, as vegetation dominated by *Sphagnum* species does not release as much methane, as they enable its re-oxidisation (Frenzel & Karofeld, 2000; Kivimäki, 2008).

The structure of *Sphagnum* moss plays a role in controlling the flow of water. The fibrous structure of some species allow them to hold twenty times their own weight in water.

*Sphagnum* mosses are, however, easily damaged by grazing, burning or any lowering of the water table. They are also sensitive to both SO<sub>2</sub> pollution and nitrogen deposition.

## **WATER REGULATION**

Peatlands play an important role in regulating water, particularly higher up in catchments, and in maintaining water quality. Globally, peatlands are thought to contain about 10% of freshwater volume (Joosten and Clarke 2002). In the UK, 70% of drinking water supplies come from upland catchment areas, which are commonly dominated by peatlands (Labadz *et al.* 2010).

Healthy peatlands store water and can potentially play a role in mitigating flooding downstream. Damage to peatlands, especially where there are grips/drainage channels or loss of vegetation, can increase the speed of water leaving the peatland (Labadz *et al.* 2010). Dissolved and particulate organic carbon have been found in higher concentrations downstream of disturbed peatlands (Scottish Government 2010a).

## **AESTHETIC AND CULTURAL BENEFITS**

Peatlands, especially blanket bogs, provide opportunities for recreation that cannot be replicated by other habitats. They make up some of the most continuous and least altered landscapes in the UK, and support wildlife watching, hiking, grouse shooting, deer stalking and angling. Surveys have shown that people place a high value on the conservation of wild places in Scotland (MRS 2008). The cultural importance of peatlands in Scotland has been recognised with the recent inclusion of the Flow Country in the [tentative list for UNESCO world heritage sites](#).

The water-logged soils of peatlands preserve archaeological artefacts and provide an archive of up to 10,000 years of life in Britain. This includes data on past biodiversity and plant species, climate records and very well preserved remains of prehistoric society (SNH 2003).

### **Box 3: Friends of Langlands Moss LNR**

Peatlands are not just situated in rural locations and can bring important community benefits where they are close to habitation centres. Langlands Moss Local Nature Reserve is situated on the south side of East Kilbride. The Friends of Langlands Moss is a voluntary group who are working in partnership with various conservation groups and interested parties in conserving the Moss.

The group's aims are to restore the Moss for its environmental benefits and raise awareness about it. Since 2008, they have installed 30 dams in the Moss to replace dams which had either been vandalised or had broken. They are trialling new methods of drain blocking. They have held various open days with talks about the Moss and offer the opportunity to get involved with practical conservation work.

The Friends have also been active in applying for funding to replace the current boardwalk, set up interpretation signs and safety signs and re-surface access paths.

See [Friends of Langlands Moss LNR](#)

# THE STATE OF SCOTTISH PEATLANDS

Peatlands are threatened by a number of human activities. In the past, peatlands were regarded as having little value and policy actively drove their destruction with the aim to encourage more “productive uses”. This has led to a situation where many of the benefits described above have been lost or, without action, could be lost in the future.

The condition of Scotland’s protected peatlands is measured through SNH’s site condition monitoring. In 2010, 71.3% of upland bog features were classified as being in “favourable” or “unfavourable recovering” condition compared with 74% in 2005. Lowland raised bogs however show some improvement in site condition (75.7% in 2010 compared with 58% in 2005)<sup>6</sup>.

Outside protected areas, Artz *et al.* (in review) highlight the lack of co-ordination in monitoring the condition of peatlands and the consequent difficulty in establishing their overall state. There are a number of methods which could potentially be used to monitor peatlands more widely. Biological indicators such as bird numbers and vegetation surveys can be used to draw inferences about the state of peatlands. The breeding bird atlas (co-ordinated by the British Trust for Ornithology) can be used to monitor changes in distribution of species to the tetrad (2 x 2 km square) level. High quality satellite imagery is available for around 90% of the blanket bog resource and could potentially be used to show changes in vegetation type, though developing such a system would be costly. The Biodiversity Action Reporting System (BARS) collects data relevant to achieving Biodiversity Action Plan (BAP) objectives from numerous involved organisations.

Physical degradation has been mapped using, for example, erosion features. Analysis using the Land Cover of Scotland (LCS88) dataset has suggested that approximately 34% of the total area of blanket bog showed erosion features. The 1999 Soils of Scotland 1:250,000 Soil maps dataset, indicated that 31% of all peat categories were eroded (Cummins *et al.* 2011). Similarly, it is possible to estimate the extent of plantation forestry on peatlands. Other causes of degradation, however, for example the extent of drainage on peatland, have not been assessed at national scale.

However peatlands may have been damaged (and be less able to store carbon) without showing signs of physical erosion and scientific reviews such as Lindsay (2010) suggest that most peatbogs have suffered some damage. A recent re-survey of 58 lowland raised bogs in Scotland showed that of the 68% of sites considered restorable, almost all have been damaged. 97% are affected by drainage ditches and 74% by significant areas of woodland or scrub. 9% were subject to active peat cutting on a semi-commercial to commercial scale. It was found that those sites which had been actively restored had improved but overall there had been a decline in condition of raised bogs since the last survey in 1994-95 (SWT 2012).

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<sup>6</sup> Site Condition Monitoring (SCM) is carried out to determine the condition of the designated natural feature of a site. “Favourable condition” means attribute targets set for the natural features have been met; “Unfavourable Recovering” means one or more of the attribute targets have not been met on the site, but management measures are in place to improve the condition; “Unfavourable” means one or more of the attribute targets have not been met, and recovery is unlikely under the present management.



## DAMAGE TO PEATLANDS



**Figure 6:** Bare peat on walking tracks. Source: K. Marsden

Peatlands are damaged through a range of land management practices. Extensive areas have been drained and overgrazing is a serious issue in many areas.

Excessive muirburning, air pollution, afforestation, peat (or other mineral) extraction, establishment of windfarms and access tracks can all present threats to peatlands. Damage can range from a slow lowering of water levels which might not have an obvious effect for many years, to complete removal of the vegetative layer with bare peat subject to severe erosion. While peatlands are threatened by current activities in some

locations, more damage has been caused by historic activities. Even where these have been abandoned, damaged peat will continue to cause substantial net emissions of CO<sub>2</sub> into the atmosphere.

## POLLUTION

Peatlands downwind of heavy industry are affected by the deposition of pollutants. SO<sub>2</sub> pollution leads to increased acidification of soil, so that it becomes difficult for vegetation to grow (Littlewood *et al.* 2010). The disappearance of *Sphagnum* mosses from the Peak District in the nineteenth century was associated with SO<sub>2</sub> pollution, from nearby industrial activity (Yeloff *et al.* 2006). The deposition of nitrogen also has a noted effect on peatland vegetation which is outcompeted by other types of vegetation when plant nutrient levels increase. The loss of *Sphagnum* mosses leads to erosion of peat soils and the appearance of patches of bare ground, which are much more susceptible to wildfire.

## DRAINAGE

The drainage of peatlands for grazing improvements has been widespread in Britain. Even small drops in the water table can result in the loss of plants adapted to waterlogged conditions (e.g. *Sphagnum*, cottongrasses) and the cessation of peat formation. Drainage has also been shown to result in increased erosion and increases in dissolved and particulate organic carbon in water flows.

Agricultural land drainage has been encouraged since the Land Drainage (Scotland) Act 1847. Between the 1930s and 1960s, a system of state-driven land drainage schemes was set in place including subsidies for both capital and maintenance costs (Spray *et al.* 2010). Between the 1940s and 50s, there was a peak in drainage activity with an average of 20,000ha of agricultural land being drained every year over that time period (Robinson 1990). Support schemes no longer encourage drainage but cross compliance (see below) requires farmers to “maintain functional field drainage systems, including clearing ditches, unless environmental gain can be achieved by not maintaining field drainage systems.” However in order to install new drains on semi-natural land a land manager must complete an Environmental Impact Assessment (EIA) (see [Annex 2](#)).



## GRAZING, TRAMPLING

The effects of grazing (mainly wild deer and sheep) on peatland biodiversity are complex and highly dependent on local environmental and ecosystem characteristics. When grazing and trampling occur throughout the year and are intensive, they increase the scarcity of particular species. Low levels of grazing can provide biodiversity benefits on some shallower peats for example by preventing the invasion of scrub and woodland species. At higher levels, however, they are likely to affect bog species and the associated trampling causes greater levels of damage by breaking up the moss layer and exposing bare peat. Overgrazing and trampling occur at a much lower density of livestock on bogs than for other habitats.

Land management activity is supported through the Common Agricultural Policy (CAP) which in the past encouraged overstocking as subsidies were paid per head of livestock. This system has been changed and now to receive support, farmers must meet cross compliance requirements including avoiding erosion caused by livestock and overgrazing. The Less Favoured Area Support Scheme (LFASS) also sets minimum and maximum levels of grazing though these are not related to an assessment of the effects of grazing on environmental condition.



**Figure 7:** Erosion caused by trampling. Source: K. Marsden

## AFFORESTATION

About 200,000 hectares peat bog in Great Britain have been afforested (Anderson 2010). Establishing forests on peatlands requires drainage, deep ploughing and fertiliser application. This exposes peat to the atmosphere, promotes peat decomposition and can lead to erosion. The growth of trees themselves also dries out bogs and results in the loss of peatland vegetation.

After the First World War, the Forestry Commission was created and incentives introduced to encourage forest planting. In the 1970s and 1980s, tax breaks were available for those who invested in forestry. By the late 1980s corporate interests accounted for around a fifth of the private forestry holdings (Wightman 2010). Tax breaks were abolished in 1988 after the outcry caused by, amongst other things, the planting of the Flow Country (see Box 4). In recent years, there has been an acknowledgement that planting on deep peat is not desirable for carbon sequestration, for biodiversity or from an economic perspective ([UK Forestry Standard \(UKFS\)](#)).



**Figure 8:** Forest blocks. Source: K. Marsden

## WIND FARMS

There has been increasing concern about the damage caused by windfarms developed on deep peat. The installation of turbines and the roads needed to serve them can result in the drainage and drying of the surrounding peat and consequent release of carbon.

Concerns about loss of carbon were cited when Lewis Wind Power's 181-turbines project on the Lewis Peatlands was rejected by Scottish Ministers (BBC News 2008). Since then, SNH and SEPA have developed guidance on good practice and how to manage peat which has been disturbed through building activities (SNH 2010b, SEPA (b)). Scottish Renewables together with RSPB Scotland, WWF Scotland, Friends of the Earth Scotland and the Scottish Wildlife Trust have drawn up good practice principles to help windfarms be suitably sited with minimal adverse environmental damage (Scottish Renewables 2010). The Scottish Government has also developed a methodology to calculate carbon emission savings associated with wind farm developments on Scottish peatlands (Scottish Government 2011b).



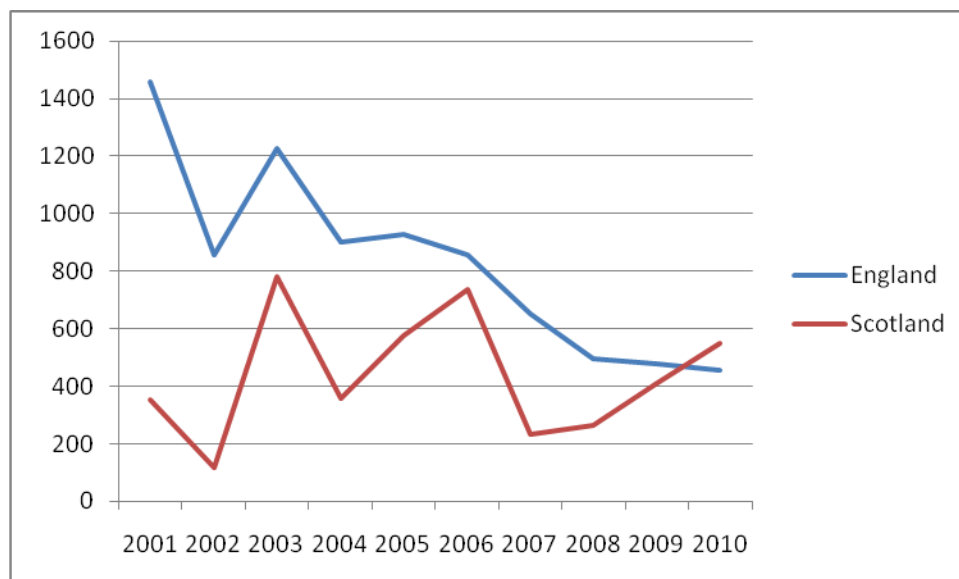
*Figure 9: Wind turbines. Source: K. Marsden*

## CUTTING/EXTRACTION

In Scotland today, peat is extracted primarily for compost production and activity is concentrated on lowland raised bogs as the type of peat found here is most suitable for this purpose. As well as the physical loss of peat, the extraction leads to drying, loss of vegetation and further loss of peat through decomposition. Biodiversity is likely to shift away from peatlands where extensive extraction has taken place. Smaller scale extraction on blanket bogs is carried out by crofters who are permitted to cut peat for their own use, but not for sale. Whisky distilleries also use small amounts of peat during 'kilning' to impart a distinctive flavour to the drink. About 5.5% of Scotland's blanket bogs show evidence of peat cutting (Artz *et al.* in review).

In 1990 the Peatlands Campaign Consortium (PCC), a coalition of conservation organisations began calling for a ban the use of peat in compost. In 1992, the UK Government established a Peat Working Group which set targets for peat substitution and best practice principles. This has resulted in the development of peat free composts using materials such as garden cuttings (e.g. [Forth Resource Management](#)). The UK Government also bought out rights on several lowland raised bogs including Flanders Moss near Thornhill (Alexander *et al* 2008). In Scotland, the [Scottish Planning Policy](#) (2010) states that extraction is "only acceptable in areas of degraded peatland which has been significantly damaged by human activity and where the conservation value is low and restoration is not possible."

The amount of peat extracted commercially in Scotland has fluctuated around 440,000 m<sup>3</sup> per year for the last ten years UK (National Statistics). Peat extraction in the UK has fallen over the last ten years by around 800,000 tonnes though the reduction has occurred in England only (see figure 10). However, peat sales in the UK amount to about 3 million m<sup>3</sup> per year, two thirds of which is imported (Scottish Government 2010a) suggesting the problem may be being exported outside the UK. In 2010, peat was extracted from 23 active sites, 6 of which are used as energy sources (for whisky) and the rest for horticulture (BGS 2010). About 20,000 tonnes of peat is cut for fuel in Scotland every year (SNH 2008).



**Figure 10:** Extraction of peat in Scotland and England (1000 m<sup>3</sup>), source: UK National Statistics

## BURNING/MUIRBURN

Burning is used on some managed moors with the aim of removing older, less productive vegetation and litter to encourage regeneration of young heather which is more palatable to grouse and sheep. It is thought that around 18% of UK peats are subjected to prescribed burning; however, it is unevenly distributed across the UK. Depending on where and how burning is carried out, it can have positive and negative effects on ecosystem services (Worrall *et al.* 2010b). An appropriate regime depends on management objectives and whether these are targeted most at grouse or livestock production or restoration of blanket bog for wildlife or securing the carbon store in the peat. On deeper peat, burning can lead to a shift away from moss to heather-dominated vegetation. (IUCN 2011a). This suggests soil carbon would be negatively affected as peat would accumulate more slowly. However, much larger effects on carbon storage are seen if burning is poorly managed particularly if the peat itself catches fire (Towers *et al.* 2012).

Wildfires on peatbogs are a serious concern as once established they are difficult to extinguish and can release significant amounts of carbon. The effects of prescribed burning on wildfires is unclear. Worrall *et al.* (2010b) describe how some believe that muirburn reduces the amount of available, dry fuel and thus the risk of wildfires while there are also concerns that prescribed burning may increase the risk of wildfires or encourage the development of an ecosystem that is less fire-resistant.

Consultation around the Wildlife and Natural Environment Bill showed that many considered that the muirburn code could be revised to better take account of the carbon implications of burning. The Scottish Government is planning a revision of the code and is exploring the possibility of the Moorland Forum carrying out a review starting towards the end of 2012. A key issue for the review would be to consider the implications of burning on soil and carbon storage.



## PEATLAND RESTORATION

The restoration of peatlands aims to re-establish peatland function, species and habitats and associated ecosystem services including the storage of carbon already held within the peat. It can also help peatlands adapt to climate change (see Box 5). Restoration generally will involve action to reverse the cause(s) of degradation and raise water levels. For example, grip blocking, grazing reduction or changes to muirburn may be sufficient to raise the water table and allow bog vegetation to re-establish in less seriously damaged peatlands. Where damage is more severe, however, restoration may require filling in of erosion channels or the reseeded of bare peat, sometimes holding the peat together using an artificial substrate and temporary 'nurse crop' to stabilise the soil surface (Littlewood *et al.* 2010). Recent restoration projects in Scotland (e.g. Forsinard in the Flow Country) have also involved the removal of trees and scrub (see Box 4).



**Figure 11:** Restoration of bare peat at Black Hill in the Peak District – before (2006) and after. Source: Moors for the Future Partnership

The UK Biodiversity Action Plan (UK BAP) has a target for blanket bog restoration, of which Scotland's share is around 600,000 hectares. 6.6% of Scotland's blanket bogs are included in protected sites (Artz *et al.* in review) while an estimated 20% of raised bogs are protected (Artz pers. comm.) and large restoration projects have been funded through EU biodiversity support (the LIFE programme). Biodiversity targets have been the main driver for peatland restoration projects up until now. The storage of carbon is now seen as another important aim, as is water management. These aims can be complementary. It has been estimated that meeting the UK BAP target could prevent 2.7Mt CO<sub>2</sub> equivalent from entering the atmosphere each year (RSPB Scotland 2010).

The Scottish Government supports restoration for the following reasons:

“Restoration benefits in the first few years are best described in habitat and biodiversity terms; carbon gains are likely to be small initially, but restoration measures should prevent further carbon losses and any further degradation.” (Scottish Government 2010a).

The Rural Priorities scheme includes some measures to encourage the better management of peatlands e.g. wildlife management on upland and peatland sites, moorland grazings on uplands and peatlands and management/restoration of lowland raised bogs. However, payment rates, especially for the upland measures, are low per hectare which may affect uptake. Capital costs for tree removal, grip blocking and heather restoration are also supported and can help fund larger scale restoration projects. The Scottish Government has put funding into research

work on peatland restoration carried out by RSPB and SNH (Scottish Government 2010b) as well as funding scientific studies into peatland through its broader research programme.

In recent years there has also been interest from business in peatland restoration. Dissolved and particulate organic carbon is expensive to remove from water and English water companies have started investing in peatland restoration as a means to reduce water treatment costs. Projects include Exmoor restoration project (South West Water 2009) and Peak District moors, where Yorkshire Water are involved in restoration (Yorkshire Water 2011). Scottish Water has established a [Sustainable Land Management: Best Practice Incentive Scheme](#) which could potentially fund projects to reduce erosion and dissolved organic carbon in water. In addition, wind energy companies have invested in large scale peatland restoration projects where peatland is damaged during construction for example at Whitelee wind farm. Peatland restoration could also be of interest for sustainable flood management projects.

In future, there may be further opportunities to establish carbon offset projects on peatlands and efforts are being made to establish a Peatland Code (similar to the Woodland Code) to ensure projects are standardised (e.g. Worrall et al. 2009).



**Figure 12:** Grip damming. Source: Andrew Keen

#### **Box 4: The Caithness and Sutherland Peatlands**

The Flow Country is the name given to the Caithness and Sutherland Peatlands which make up the largest blanket bog in Europe (400,000 hectares). The peatlands here are thought to store 400 million tonnes of carbon and are recognised as being of international importance for biodiversity. They hold important European bird species such as black throated diver, golden eagle, golden plover, hen harrier and merlin (RSPB 2010).

In the 1970s-1980s tens of thousands of hectares of the Flow Country were planted with conifers. The Nature Conservancy Council (predecessor to SNH) and RSPB Scotland led a campaign to remove the tax breaks encouraging planting of the Flows and to designate the remaining areas as protected sites. Around 145,000 ha (36%) is now designated (Scottish Government 2010a).

In 1994, RSPB Scotland, SNH and Caithness and Sutherland Enterprise received funding from the EU LIFE programme to improve awareness and the conservation status of the bogs. In 1995, RSPB acquired its largest nature reserve, Forsinard Flows, in the flow country. This was followed by a further LIFE Nature project in 2001 run by RSPB Scotland, SNH, Forestry Commission and Plantlife. These organisations have worked together with members of the local community as the Peatlands Partnership to continue to raise money and awareness for the Flows restoration since.

Over the course of this time, large areas of bog have been restored from forestry. 15,600 hectares of bog have had drains blocked and 2,200 hectares of forestry have been removed.



RSPB has also calculated the benefits to the local economy at £190,000 per year from the 4000 annual visitors to the reserve.

The Flow Country has been added to the [tentative list for UNESCO world heritage sites](#). The site meets the UNESCO criteria for its “outstanding importance [...] in its extent and continuity, the diversity of mire and vegetation types, and the on-going processes of bog formation which it exhibits” and “The size and range of the bird populations that it supports, as well as concentrations of other rare species.”

See RSPB (2011), Lindsay *et al.* (1988), SNH (2009)

While peatland restoration has clear benefits, measurement of these benefits is complex and upfront capital costs are high which may make projects difficult to establish in a time of low Government spending. Moxey (2011) described median costs of £1,500 per hectare though this is likely to have been increased by the costs of land acquisition for some projects. Typical grip blocking restoration costs are in the region of £240/hectare with much lower costs for near-natural sites. Moxey (2011) points out that these costs compare favourably with other climate change mitigation measures. The costs and benefits in terms of carbon and capital costs of different restoration possibilities therefore need to be considered as, while upfront costs may be higher, the largest carbon savings can be made from the most degraded sites.



**Figure 13:** Grip re-profiling, source: North Pennines AONB Partnership. Grip blocking, source: Yorkshire Wildlife Trust

The restoration of peatlands may also exclude some current land uses. In some cases it may be necessary to reduce grazing or burning. The benefits of current land use compared with the restoration of a peatland area therefore need to be considered.

Artz *et al.* (in review) considered these problems and used them to develop a decision support tool to help select sites for peatland restoration. They asked stakeholders to assess the relative importance of 19 site selection criteria including current state, current use and costs of restoration. This allowed them to highlight some areas with potential for restoration in Scotland.



## POSSIBLE FUTURE POLICY DRIVERS

The management of peatlands has been attracting an increasing level of policy interest in recent years. While research has been carried out on Scottish peatlands for many years, the recent [IUCN UK Peatland Programme](#) and their Commission of Inquiry on Peatlands based in Scotland has been instrumental in drawing together much information and focusing attention on the benefits that peatlands in good condition can provide. It has also drawn together different interest groups such as land managers, NGOs and Government bodies to reach consensus on some of the key issues. Conservation bodies have also carried out significant pieces of work to encourage peatland restoration for multiple environmental benefits (Lindsay 2010, SWT 2012). The Moorland Forum's [Peatland Working Group](#) is also promoting discussion amongst a wider group of interested bodies on the future for Scotland's uplands and their communities.

The Scottish Government set out its views on peatlands in a discussion paper on carbon rich soils (Scottish Government 2010a) as well as in the 2011 Report on Proposals and Policies (RPP) for the Climate Change Act (see below). It was an SNP manifesto commitment to "take action to protect and restore peatlands". The Scottish Parliament has [debated investing in the future of Scotland's peatlands](#) (Scottish Parliament 2010) and the Rural Affairs Environment and Climate Change Committee is holding evidence sessions on peatland in 2012.

The section below sets out some of the future drivers for peatland policy. For a comprehensive list of the policies affecting peatland see [Annex 2](#).

## CLIMATE CHANGE POLICY

Carbon storage is likely to increase in importance as a driver for future changes in peatland policy. A review of the potential afforded by restoring Scottish degraded peatlands suggests that the "net potential abatement benefits from peatland restoration" lie somewhere between 0.6 and 8.3 tonnes of CO<sub>2</sub> equivalent per hectare per year (Artz *et al.* 2012). Peatland restoration therefore has the potential to help meet Scotland's climate change targets. The [Climate Change \(Scotland\) Act 2009](#) requires a reduction in emissions of 80% from 1990 levels by 2050, with an interim target of 42% by 2020. Since much peatland damage predates 1990, restoration work which reduces emissions from damaged peatland would be counted as a reduction of CO<sub>2</sub> emissions.

In the [2011 Report on Proposals and Policies \(RPP\)](#), the Scottish Government included peatlands as a "Supporting and Enabling Measure", but suggested that in future they may "incorporate consideration of peatland restoration into the methodology for calculating the net Scottish emissions account" (Scottish Government 2011a). While uncertainties about how greenhouse gas fluxes from peatlands can be measured have meant that they have so far not been included, there have been calls for early action on peatland restoration as a form of "preventative spend". In evidence to the RACCE Committee's budget scrutiny, IUCN described it as a "no-regret option" which would help meet biodiversity targets, spread cost of restoration and could be accounted for in retrospect when carbon figures are finalised (IUCN 2011b).

The Scottish Government can decide whether to include peatland in its own national accounting but there are also moves to account for restoration of wetlands internationally. Currently Land Use, Land Use Change and Forestry (LULUCF) is only partially included in Kyoto Protocol reporting. At the UNFCCC Durban Climate Change Conference it was agreed to allow parties to include wetland drainage and rewetting in reporting ([Decision 2/CMP.7](#)). The Intergovernmental Panel on Climate Change (IPCC) will develop a "2013 Supplement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories: Wetlands". This means that for the next commitment

period it should be possible to count carbon sinks from peatland rewetting towards emission reduction targets. This could also result in carbon markets being established for wetland restoration and their inclusion in the protocol's flexible mechanisms (allowing trading of carbon between countries). Parties to the protocol such as the UK will need to decide whether to include emissions and absorptions of carbon by wetlands before the next commitment period starts (UN 2012).

#### **Box 5: The effect of climate change on Scottish peatlands**

Peatlands are vulnerable to climate change. As temperatures increase, the areas suitable for peatlands in Scotland could reduce with the south and east of their range likely to be under greatest stress (Gallego-Sala 2010). High water tables in peatlands are maintained by high rates of precipitation and low evapotranspiration. Peatlands are particularly sensitive to changing weather patterns for the following reasons:

- Higher temperatures lead to drying out of peat, falling water table, cracking and erosion
- Increased likelihood of wildfire, leading to significant vegetation loss
- More heavy rainfall events are likely to cause more erosion on damaged peatlands

However, specific changes to particular peatlands are very difficult to predict. Climate model predictions apply over large regions and their implications are often difficult to interpret at small scales. Warming is expected to have the most significant effect on peatlands that are already degraded and under pressure – pristine bogs may be more resilient to small changes in temperature (Clark *et al.* 2010).

Climate change may also affect peatland biodiversity. For example, research has shown that changes of temperature affect the abundance of adult craneflies at the time when golden plover use them to feed their young. Increasing temperatures are therefore likely to drive golden plover populations north and their range will also be limited by habitat abundance (Pearce-Higgins *et al.* 2009).

The UK Committee on Climate Change Adaptation Sub-Committee suggests that climate change may prompt an expansion of agriculture from the east to the west on Scotland, and that this would have the potential of having adverse effects on the peatlands in the west of Scotland. The report criticises the Scottish Government's preparedness for the changes that could be brought about by climate change noting:

“neither the Land Use Strategy nor the relevant adaptation sector plans explicitly consider the risks from both future land use change and climate change to Scotland's globally important peatlands. This could be a potentially significant gap in the adaptation framework” (UKCCC 2011)

*See Worrall (2010a), Joosten (2010), Clark et al. (2010) for more information.*

## **COMMON AGRICULTURAL POLICY**

The EU has also been looking at how carbon emissions from agriculture can be better taken into account. A recent [Commission Communication and legislative proposal](#) outlined how the LULUCF sector can be integrated into carbon accounting and eventually emissions trading. The Commission would like to include better management of soil carbon in the reformed Common Agriculture Policy. The proposals include a new obligation not to plough wetlands and carbon rich soil and permanent pasture should be protected through a series of “greening measures”.

The Commission is also pressing for the establishment of a legally binding instrument on soil policy though proposals have stalled since 2006 (see [Annex 2](#) for more information).

## BIODIVERSITY POLICY

Biodiversity policy is likely to remain a driver for restoration in the future. Scotland (and the rest of the EU) failed to meet the 2010 biodiversity targets and a new Scottish Biodiversity Strategy is being developed with consultation planned over summer 2012 in order to help meet the new 2020 target to halt biodiversity loss.

## INTEGRATED LAND USE POLICY

Peatland restoration has multiple aims and multiple potential benefits. The [Land Use Strategy](#), required by section 57 of the Climate Change Act, attempts to set in place a vision for the better integration of different types of land uses in Scotland. Although the strategy encourages multiple uses, it specifies that where land is highly suitable for one primary use (such as carbon storage) this value should be recognised in decision making. Peatlands are specifically mentioned for their importance in the context of climate change. The land use strategy is in its early days. A recently produced [Action Plan](#) laid out current policies on land use and some ideas about how they could be better integrated (Scottish Government (a)). It is unclear as yet how the strategy will influence other land use policies.



**Figure 14:** Windfarms, forestry and agricultural land. Source: K. Marsden

## ANNEX 1: ECOSYSTEM SERVICES

Ecosystem services provided by peatlands and classified as 'high value' by the UK National Ecosystem Assessment.

		<b>Healthy Peatlands</b>	<b>Degraded peatlands</b>
Provisioning Services	Water supply	Reduce downstream flood risk by acting as a reservoir: absorbing water and releasing it slowly	Increased hydrological risks, compared with undisturbed bogs.
	Wild species diversity	Support nationally and internationally important (and protected) species	Habitat degradation results in loss of species.
Regulating Services	Climate, GHG, Carbon	Sequestration of CO <sub>2</sub> over long timescales	Exposed peat releases large volumes of CO <sub>2</sub> , as well as methane and nitrous oxide.
	Wildfire hazard	Low risk (high water table, and healthy bog vegetation prevents fires from spreading)	Higher risk during sustained warm periods
	Water quality	Provide high quality, clean water, some carbon pollutants removed by natural filtering	Increases in dissolved and particulate organic carbon (DOC,POC) downstream of disturbed peatlands
Cultural Services	Cultural Heritage/aesthetics	Anaerobic conditions allow the preservation of artefacts,	Decomposition of peat would lead to exposure and eventual loss of archaeological record
	Recreation/ Education/ Spirituality	Healthy peat bogs are attractive and provide opportunities for walking, recreation relating to wildlife and sites for reflection	Bare peat is unsuitable for walking, especially when wet. Loss of biodiversity results in reduction in attractiveness of landscape.
Supporting Services	Soil Formation	Peat and Carbon-rich soils are formed	Where peat is exposed to the atmosphere, it breaks down
	Nutrient cycling	Healthy wetlands fix nitrogen and facilitate deposition of nutrients and sediments	Some limited grazing can increase nitrogen fixation and enrich soil. Lower of water table and exposure of peat may interrupt the process.
	Biodiversity	Support nationally and internationally important (and protected) species	Habitat degradation results in loss of species.

See the UK NEA (2011) and Whitfield et al. (2011).

## ANNEX 2: POLICIES RELATING TO PEATLANDS

Level	Requirements
<b>Climate Change</b>	
International	The UNFCCC <a href="#">Kyoto Protocol</a> , requires Annex 1 parties to reduce emissions of greenhouse gases by at least 5% below 1990 levels by 2012. Targets for a second commitment period will be agreed by 2015. Under current provisions Land Use, Land Use Change and Forestry (LULUCF) is only partially included in reporting to count towards this target. At the Durban Conference, it was agreed that parties can choose to include wetland drainage and re-wetting in their carbon accounting for the second commitment period ( <a href="#">Decision 2/CMP.7</a> ).
EU	The EU has committed to reduce its greenhouse gas emissions by 20% below 1990 levels by 2020, and by 30% if conditions are right. Carbon dioxide emissions from LULUCF are not included in the commitments. A recent <a href="#">Commission Communication and legislative proposal</a> outlines how the LULUCF sector can be integrated.
Scotland	<p>The <a href="#">Climate Change (Scotland) Act 2009</a> requires a reduction in emissions of 80% by 2050, with an interim target of 42% by 2020 (if more stringent targets are also set across the EU). Peatlands are not included in the accounting calculations but peatland restoration is described as a “supporting and enabling” measures in the <a href="#">2011 Report on Proposals and Policies (RPP)</a>. The Scottish Government will consider incorporating peatland restoration in calculations for Scotland’s net emissions once IPCC has agreed a methodology for the calculation.</p> <p>The <a href="#">Land Use Strategy</a>, required by section 57 of the Climate Change Act attempts to set out a vision for integrated land use in Scotland. Although the strategy encourages multiple uses, it specifies that where land is highly suitable for one primary use (such as carbon storage) this value should be recognised in decision making. Peatlands are specifically mentioned for their importance in the context of climate change.</p>
<b>Biodiversity</b>	
International	<p>The UN <a href="#">Convention on Biological Diversity</a> aimed to achieve a significant reduction of the current rate of biodiversity loss by 2010. The <a href="#">Aichi Targets</a> were agreed at the 10<sup>th</sup> Conference of the Parties in Nagoya and set a series of goals for 2020. Parties must develop plans for the sustainable use of biodiversity and integrate it into relevant cross-sectoral plans.</p> <p>The <a href="#">Ramsar Convention</a> came into force in 1975. It is an intergovernmental treaty providing a framework for cooperation on the conservation and wise use of wetlands and their resources. Wetlands are classified and protected according to their hydrological or biological importance. Under the convention, the importance of wetlands for climate has also been highlighted and <a href="#">Guidelines for Global Action on Peatlands (GAP)</a> were adopted in 2008.</p>
EU	<p>The European Commission’s overarching strategy for halting biodiversity loss by 2020 is set out in the <a href="#">Biodiversity Strategy</a>. In order for the strategy to be successful, there will be an aim to adopt biodiversity measures into other relevant EU policies.</p> <p>The <a href="#">EU Birds Directive</a> protects particular species of birds and their habitats. Member States must protect Special Protected Areas (SPAs) targeting these species some of which are likely to rely on peatland habitats. The <a href="#">Habitats Directive</a> extended protection to habitats and species other than birds. It requires the establishment of Special Areas of Conservation (SACs) which together with SPAs make up the Natura 2000 network. Annex 1 of the Directive lists the natural habitat types whose conservation requires the designation of SACs including blanket bogs.</p> <p>The <a href="#">LIFE programme</a> is the EU’s funding instrument for the environment. The general objective of LIFE is to contribute to the implementation, updating and development of EU environmental policy and legislation by co-financing pilot or demonstration projects. LIFE has a wetland theme which is targeted at supporting the conservation of wetland ecosystems within the Natura 2000 network.</p>
Scotland	Biodiversity policy has been implemented through the establishment of the <a href="#">UK Biodiversity Action Plan (UK BAP)</a> (1994). The UK BAP for blanket bog includes a target to ensure that 845,000 ha of



	<p>bog (around 75% of the total) is in or approaching favourable condition by 2015. The <a href="#">Scottish Biodiversity Strategy</a> (2004) set up ecosystem groups to establish plans of action. Peatlands may be included in a number of these but the freshwater and wetland and upland groups are particularly relevant. The current strategy is being reviewed in the light of the new Aichi Targets and EU strategy.</p> <p>Scotland has also set in place a Natura 2000 network as required by the Birds and Habitats Directives. A number of the sites under these designations are peatlands (for example the Caithness and Sutherland peatlands and the Lewis peatlands).</p>
<b>Water</b>	
EU	<p>The EU <a href="#">Water Framework Directive</a> (WFD) aims to achieve good ecological and good chemical status for water bodies. The main mechanism for doing this is the introduction of River Basin Management Plans (RBMP). The WFD protects wetlands linked to surface or groundwater bodies but not if they are dependent solely on rainwater. There is therefore some debate about whether bogs are included in the WFD aims to achieve good status.</p>
Scotland	<p>The WFD, is implemented through the <a href="#">Water Environment Water Services (Scotland) Act 2003</a> (WEWS). The <a href="#">Water Environment Restoration Fund</a> provides funding to help meet WFD objectives and may support restoration of wetlands to improve the status of associated water bodies.</p> <p>The <a href="#">Flood Risk Management (Scotland) Act 2009</a> encourages a more natural approach to flood management which might include the restoration of wetlands where this is thought to reduce flood risk.</p> <p>Scottish Water also runs a <a href="#">Sustainable Land Management: Best Practice Incentive Scheme</a>. This is mainly focused at land managers' actions to reduce diffuse pollution though it could also fund projects to reduce erosion and dissolved organic carbon in water through wetland and peatland restoration.</p>
<b>Soil</b>	
EU	<p>The European Commission adopted the <a href="#">Thematic Strategy for Soil Protection</a> in 2006. A part of this was a proposal for a Framework Directive for the Protection of European Soil with legislative proposals to protect and restore soils. The proposal has been blocked by a small group of the larger Member States (UK, France, Germany, the Netherlands and Malta). The Commission recently released a proposal to reopen discussions around the proposed directive.</p>
Scotland	<p>The <a href="#">Scottish Soil Framework</a> (2009) linked the various policies impacting on soils. It was followed by a discussion paper on the <a href="#">Management of Carbon-Rich Soils</a> which set out Scottish Government views on the management of peatlands and other carbon rich soils.</p>
<b>Agriculture</b>	
EU	<p>The <a href="#">Common Agricultural Policy</a> directs financial support to farmers across the EU. In order to receive support, farmers must respect Cross Compliance rules. A part of this is keeping land in Good Agricultural and Environmental Condition. The GAEC rules currently include measures to maintain soil organic matter as well as reducing erosion and maintaining structure. The CAP is currently being reformed and a new obligation not to plough wetlands and carbon rich soil is proposed. In addition, permanent pasture should be protected through a series of "greening measures".</p> <p>Pillar 2 of the CAP, Rural Development support, includes payment for measures to manage and protect the environment which can include restoration of peatlands.</p>
Scotland	<p>The Scottish interpretation of GAEC includes a number of peatland relevant measures. In particular, land managers must respect the muirburn code (controlling heather burning) and the requirements of agricultural EIAs (see below).</p> <p><a href="#">Rural Priorities</a> is part of Pillar 2 in Scotland. It supports a number of options which could contribute towards peatland management and restoration e.g. wildlife management on upland and peatland sites, moorland grazings on uplands and peatlands and management/restoration of</p>



	lowland raised bogs.
<b>Forestry</b>	
Scotland	<p>The <a href="#">Scottish Forestry Strategy</a> (2006) includes an aim to increase forestry cover to 25% of the land area in Scotland to tackle climate change and stimulate economic development. It is agreed that to make the largest carbon sequestration gains, woodland creation is best focused away from the deeper peat soils.</p> <p>The <a href="#">UK Forestry Standard (UKFS)</a>, the standard applying to all Forestry Commission grant schemes and felling licensing was recently revised to allow forestry removal for peatland restoration. As part of the standard, for biodiversity and soil protection reasons, foresters should avoid establishing new forests on soils with peat exceeding 50 cm depth and on sites that would compromise the hydrology of adjacent bog habitats.</p> <p>The <a href="#">Woodland Carbon Code</a> sets out rules for carbon sequestration projects. It specifies that only woodland creation projects on soils which are not organic will be eligible. Afforestation of peatland is therefore specifically excluded.</p>
<b>Planning</b>	
Scotland	<p>The <a href="#">Scottish Planning Policy</a> (2010) sets out national planning policy. Developers are required to assess the likely effects on stored carbon and greenhouse gas emissions of the disturbance of soils, particularly peat. On the section on mineral extraction, it states: “peat cutting raises particular environmental concerns, and will only be acceptable in areas of degraded peatland which has been significantly damaged by human activity and where the conservation value is low and restoration is not possible.”</p> <p>Environmental Impact Assessments are required for all new developments and should take account of emissions of greenhouse gases. Further guidance is available for particular sectors. Windfarm developers are required to take account of the effects of establishment on peatlands and Scottish Government has provided a <a href="#">methodology to calculate potential carbon losses and savings</a>.</p> <p><a href="#">Agricultural EIAs</a> constrain operations to carry out 'intensive' agricultural operations on uncultivated or semi-natural land. They therefore restrict intensification such as new ploughing or drainage works on many peatlands.</p>

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