IUCN UK Committee Peatland Programme
*Briefing Note N°**10***

Peat Bogs, Climate and Climate Change

Effects of climate change

Peat bogs are by definition **supplied with water exclusively as direct precipitation** (see ***Definitions Briefing Note 1***). Bogs are therefore **highly dependent upon the frequency and amount of precipitation** they receive in order to remain waterlogged and functioning effectively. While temperature and solar radiations are important, **air humidity** is also important because, if the air is fully saturated, these precipitation inputs cannot then be lost back to the atmosphere through evaporation or transpiration by plants.

Humidity

Occult precipitation

Hidden or 'occult' precipitation in the form of hill fog and dew-fall can contribute almost 20% to annual inputs and more than 50% of daily water inputs on foggy days in Newfoundland blanket bogs. This is water which can readily be taken up by *Sphagnum* mosses because these plants do not have a waterproof cuticle. Frequent low cloud on UK hills can provide moisture in the same way. **Air temperature** is thus also important because as air becomes warmer it can take up more moisture before becoming saturated, but equally release more when it cools.

Air temperature

Climate models

Precipitation patterns and air temperature are widely regarded to be key factors in climate change, and consequently there has been growing concern about the possible effect of climate change on peat bog ecosystems. Current **climate models** based on greenhouse gas emissions scenarios for the UK broadly **project higher temperatures, generally drier summers and wetter winters**, with the degree of change being influenced by the severity of each emissions scenario. A larger proportion of the rainfall is also expected to fall in heavier rain events.

Water table draw down

The models for UK peat bogs also therefore predict that **water table draw-down in peat bogs during summer will become more marked**. A number of studies suggest that this will have a negative impact on UK peat bog ecosystems.

Active bogs existed in Cambridge-shire until drained in the 1850s

However, the parameters of such models in the UK are based on the existing distribution of peat bog systems and assume that areas currently lacking such peatland systems lie outside the 'climate envelope' for peat bog formation. **The lack of such systems in the south and east is, however, more a reflection of human activity than climate**, with Holme Fen (confusingly, a raised bog rather than a fen) in Cambridgeshire demonstrably having been an active raised bog until it was drained in the 1850s. Furthermore, future-climate models are at their weakest when predicting cloud cover, air humidity and events such as hill fog and dew-fall.

Peat archive

Present models also do not take account of the biological response of the living surface to changing conditions. Evidence from the **peat archive** indicates that **drier conditions, and thus lower water tables, have occurred in the past and yet the peat has often continued to accumulate** even during these periods.

Resilience to climate change

This **resilience in the face of climate change has been convincingly linked with the living surface of 'active' bogs** whereby, in dry conditions, pattern structures such as pools become overgrown as ridges and hummocks expand, with individual *Sphagnum* species typical of wetter pattern features being replaced by *Sphagnum* species more suited to drier conditions (see ***Biodiversity Briefing Note 2***). Not only are these 'dry climate' *Sphagnum* species adapted to the levels of water-table draw-down predicted in current climate models, but they are **more resistant to decomposition than species which dominate during wetter climate phases**. This may therefore mean that during drier phases the rate of peat accumulation might actually have *increased*.

Resistance to decomposition

Resistance to drying out

Furthermore, when *Sphagnum* dries it becomes very pale or even white, thus forming a thin, highly reflective layer on the bog surface. The **absence of vascular tissue in the stem of *Sphagnum* means that water is not readily transmitted up the stem even when the upper part of the plant is dry**. Consequently the *Sphagnum* carpet may remain extremely damp just a few centimetres below the drought-bleached surface layer.

Adaptive capacity relies on vegetation and surface patterning

This **resilience in the face of climate change** has resulted in almost continuous peat formation for, in some cases, almost 10,000 years in the UK. Such **adaptive capacity however, relies on the presence of an 'active' living peat bog surface (*i.e.* vegetation and surface pattern)**. Recent surveys have identified that more than 80% of UK peat bogs now lack such an active living surface as a result of human impacts, and that they therefore now have little or no capacity for resilience in the face of future climate change. Restoration of UK peat bog to an active state is therefore essential to increase the opportunities for a biotic response, increasing the future resilience of UK peat bogs to climate change.

Impacts of climate change

Damaged bogs lacking an acrotelm are currently losing most carbon

Unprotected peat eroded by heavy rainfall

Increased temperatures may lead to increased decomposition of peat-forming material in active, healthy bogs, although this is still an issue of debate. What is quite certain, however, is that peat bogs which lack a living, healthy acrotelm (see ***Biodiversity Briefing Note 2***) are **already losing their long-term carbon store** and will do so at an **increasingly dramatic rate under predicted changes to the UK climate**.

As well as carbon loss directly to the atmosphere through **oxidation** of the peat (see ***Drainage Briefing Note 3***), unprotected peat will be **eroded** from the un-vegetated surface by heavier rainfall events (see ***Erosion Briefing Note 9***) leading to **further carbon loss and reduced water quality**.

Areas at risk

The bog most at risk are **damaged and degraded haplotelmic bogs**, in other words those which have lost the surface acrotelm of peat-forming species (see ***Biodiversity***

Haplotelmic (damaged) bogs most at risk	***Briefing Note 2***) and which are dominated by species that are not normally peat forming or which are dominated by areas of bare peat. Unlike active healthy bogs these **haplotelmic bogs are unable to respond to climate change with any stabilising feedback mechanism**. Their most likely response is decomposition and degradation of the peat stored in the unprotected catotelm leading to high rates of carbon loss. Further areas that require restoration or attention are those of partially damaged bogs with a reduced complement of peat forming species and/or poor *Sphagnum* cover, which whilst in better condition than haplotelmic bogs, still require a full complement of *Sphagnum* mosses and peatland vegetation to provide the necessary resilience for climate change.
Benefits of addressing the issue	The benefits of a programme of bog restoration are: • Improved carbon sink and storage. • An active bog capable of a biotic response. • Increased peat bog biodiversity. • Improved water quality.
Gaps in Knowledge	The major questions and gaps in current research knowledge are: • Can climatic models for UK peat bogs take into account the biotic response of peat bog vegetation in response to future climate change? • Can climatic models for UK peat bogs better account for the current or former known distribution of bog-forming species and habitats? • How can climatic models for UK peat bogs adequately take into account the contribution of occult precipitation (fog, mist, dew) to the water budget of peat bog systems? • More evidence is required about the detailed nature of the response shown by the living surface (vegetation and surface pattern) and the rate of peat accumulation in the face of previous climate change, as shown in the peat archive. The limits of any such adaptive resilience are not well known or understood, but are important in understanding likely thresholds of resilience.
Practical Actions	Practical actions: • Restore 'non-active' bogs to an 'active' peat-forming state. • Restore partially-damaged active bogs to increase adaptive resilience to climate change. • Investigate detailed record of climate-change responses contained within the UK peat archive. • Adapt existing climatic models or create new models for UK peat bogs, incorporating the species/patterning biotic response. • Measure and model potential inputs from occult precipitation (fog, mist, dew) under differing climate scenarios. • Monitor the effects of climate change on peat-forming species such as growth rate and cover and assess the contribution of restoration work to this.

More Information	Underpinning scientific report: http://www.rspb.org.uk/Images/Peatbogs_and_carbon_tcm9-255200.pdf (low resolution) http://www.uel.ac.uk/erg/PeatandCarbonReport.htm (high resolution : downloadable in sections) IUCN UK Peatland Programme: http://www.iucn-uk-peatlandprogramme.org/ Natural England Uplands Evidence Review: http://www.naturalengland.org.uk/ourwork/uplands/uplandsevidencereviewfeature.aspx Scottish Natural Heritage Report on peat definitions: http://www.snh.org.uk/pdfs/publications/commissioned_reports/701.pdf Peatland Action: http://www.snh.gov.uk/climate-change/what-snh-is-doing/peatland-action/ *This briefing note is part of a series aimed at policy makers, practitioners and academics to help explain the ecological processes that underpin peatland function. Understanding the ecology of peatlands is essential when investigating the impacts of human activity on peatlands, interpreting research findings and planning the recovery of damaged peatlands.* *These briefs have been produced following a major process of review and comment building on an original document: Lindsay, R. 2010 'Peatbogs and Carbon: a Critical Synthesis' University of East London. published by RSPB, Sandy. http://www.rspb.org.uk/Images/Peatbogs_and_carbon_tcm9-255200.pdf, this report also being available at high resolution and in sections from: http://www.uel.ac.uk/erg/PeatandCarbonReport.htm* *The full set of briefs can be downloaded from:www.iucn-uk-peatlandprogramme.org.uk* *The International Union for the Conservation of Nature (IUCN) is a global organisation, providing an influential and authoritative voice for nature conservation. The IUCN UK Peatland Programme promotes peatland restoration in the UK and advocates the multiple benefits of peatlands through partnerships, strong science, sound policy and effective practice.* *We are grateful to Scottish Natural Heritage, Natural England, Natural Resources Wales, the Forestry Commission RSPB Scotland and the Peter de Haan Charitable Trust for funding support.*
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