

The sensitivity of peat-covered upland landscapes

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Abstract

Ombrogenous mires, or bogs, are remarkable in that they are organic landforms built from living plants and their partially decayed remains (peat), together with large quantities of water derived directly from precipitation. In the uplands and northwest of the British Isles, they tend to dominate landscapes wherever the slope allows. The components of ombrogenous mires are highly sensitive to change, especially in hydrology. Their vegetation may alter in response to very small changes in water level and/or water chemistry, whereas the underlying peat may undergo total degradation on dewatering. The function of intact mire ecosystems incorporates mechanisms which tend to maintain stability when environmental conditions change; observation indicates, however, that the stability threshold may be crossed under some natural as well as some man-induced circumstances. Sensitivity is demonstrated by evidence from the plant remains preserved in the peat; from manipulation of management practices (particularly grazing and burning); from long-term (28–68 years) mapping of vegetation change; and from experimentation on the sensitivity of bog plants to components of air pollution. The ultimate manifestation of sensitivity is peat erosion, which is widespread in the uplands and may, in places, have been ongoing for several hundred years. It is concluded that we may anticipate heightened sensitivity to cultural perturbation of mire ecosystems during times of climate change, and thus that particular care in our approach to management of blanket peat landscapes is indicated at the present time. © 2001 Elsevier Science B.V. All rights reserved.

Keywords: Blanket mire; Bog; Cultural influence; Environmental change; Peat erosion; Ombrogenous mire

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1. Introduction

Organic waterlogged deposits (**peat**) cover 8% of the United Kingdom’s land surface, and 10.4% of Scotland’s (Taylor, 1983). Most of these peatlands are **bogs**, and most (72%) are in Scotland (Lindsay and Immirzi, 1996; Table 1). Bogs, otherwise known as ombrogenous mires, are irrigated by precipitation only, and hence their plant communities are specialised for nutrient-poor conditions. They are very wet because they occur in climates with precipitation excess, on flat or gently sloping ground, and with drainage impeded by low soil permeability (Ingram, 1982). Dead plant material accumulates as peat beneath the living vegetation because decomposition is impeded by waterlogging.

Bog formation exerts antagonistic influences on erosion processes. On the one hand the underlying mineral soil is protected from erosion; but on the other hand surface runoff is enhanced at the expense of downward seepage so that erosive forces increase (Ivanov, 1981). Dominance of the former tendency is indicated by the fact that individual bogs have existed for thousands of years, slowly building peat deposits several metres thick.

From what we know of the structure and function of bogs, it seems that special rules determine their sensitivity to natural and man-induced change; and in order to understand the rules we must know something about mire ecohydrology.

1.1. A note on bog classification

Two types of ombrogenous mires — **raised bogs** and **blanket bogs** — are often distinguished. The idea of the “classic raised bog” indicates a discrete single dome of peat with a halo of lagg fen, overlying level mineral terrain or an infilled basin, approximately realised at Hammarmossen in Sweden (Foster et al., 1988). Where it overlies flats and basins, blanket bog may contain morphological units that resemble raised bogs, but these are typically joined together by areas of thinner peat on slopes (Wheeler and Shaw, 1995). On the basis of situation, morphology, vegetation, microtopography and sequence of development, Lindsay (1995) recognises the differences between raised and blanket bog, but regards them as the end-points of an ecological continuum, separated arbitrarily by a third class of “intermediate bog”.

The detailed form of an ombrogenous mire expresses the interaction of relief and permeability of the mineral substrate with climate, so that distinction of raised and

Table 1
Areas (ha) of peat soils in Great Britain greater than 1 m in depth (from Lindsay and Immirzi, 1996)

Country	Fen	Raised bog	Intermediate bog	Blanket bog	Total area
England	132,469	37,694	981	214,077	385,221
Scotland	1215	27,892	10,653	1,056,198	1,095,958
Wales	2867	4078	85	158,770	165,799
Total recorded peat	136,551	69,663	11,719	1,429,045	1,646,979
Total bog area				1,508,609	

blanket bogs is not particularly helpful in terms of their function. However, this paper focuses on the blanket mire systems which appear to be restricted worldwide to a few regions with wet, oceanic climate, and within Europe occur only in the uplands and northwest of Britain and Ireland and in the extreme west of Norway (Lindsay et al., 1988, pp. 27 et seq.). Well-studied blanket peat landscapes in Britain include the famous “patterned land” of the Flow Country of Caithness and Sutherland (Lindsay et al., 1988), and the peat-covered hilltops of the Scottish Borders and the English Pennines.

2. The basis of sensitivity in ombrogenous mires

The components of the ombrogenous mire system are highly sensitive to disturbance, especially of their hydrological regime. However, they also possess attributes which tend to maintain long-term stability of the system as a whole. Some of the reasons for bog sensitivity, their consequences, and compensating feedback mechanisms will now be considered. These operate through the vegetation, the structure of the ecosystem, the peat formation process and hydrology.

2.1. Vegetation

In Britain, and indeed throughout the circumboreal zone, the principal components of bog vegetation and peat are species of “bog moss” or *Sphagnum*, the most primitive genus of a primitive group of plants (Hill, 1978; Proctor, 1979). In order that *Sphagnum* can grow, water must be supplied to its apical buds; but there is no vascular system to assist in maintenance of the supply during dry weather. Thus, the *Sphagna* are normally confined to habitats less than a few decimetres above a free water surface and may disappear if average water table changes by as little as 20 mm (Ivanov, 1981). *Sphagnum* is rootless and so cannot withstand erosive surface runoff. Moreover, bog species thrive under acidic, nutrient-poor conditions and are highly sensitive to any influence which changes chemical conditions at the mire surface, for example fertiliser application, catchment liming (Bragg and Clymo, 1995) and deposition of airborne pollutants (e.g., Karofeld, 1996; Proctor, 1997).

The surface of an intact bog typically consists of a more or less continuous carpet of *Sphagnum*, whose upper surface forms the ground cover beneath woody and graminoid vascular plants. It is typically uneven, exhibiting microrelief, with convex (hummocks, ridges) and concave (hollows, furrows, pools) elements at a horizontal scale of 0.5–10 m. Although the vertical range of microrelief is only of the order of 0.5 (–1) m, each *Sphagnum* species occupies only part of this range, so that vertical zonation is evident adjacent to pools (Ratcliffe and Walker, 1958; Ivanov, 1981; Lindsay, 1995). Associated vascular plants also show differences in distribution; for example heather (*Calluna vulgaris*) is usually associated with hummocks (Ingram, 1992).

One mechanism by which the bog system can adjust to trends in climatic wetness over a period of years is by expansion of hummock vegetation during periods of dry climate, and of hollow vegetation and pools in wetter periods (Walker and Walker,

1961; Barber, 1981; Svensson, 1988). In the most strongly patterned bogs of, e.g. the Flow Country, some 50% of the bog surface on flat or very gently sloping ground may be covered with open water, in the form of pools.

2.2. *Mire structure*

It is helpful to divide the peat profile into two layers (Ingram, 1978). The lower layer, or **catotelm**, is typically 1–5 (–10) m thick and consists of dead, partly decayed plant material, which is perennially waterlogged. Indeed, its water content of 95–97% renders it less solid than milk (Eggelsmann, 1988). The upper layer, known as the **acrotelm**, is a thin surface skin, 0.2–0.8 m thick, most usefully defined as the layer which always contains the water table (Bragg, 1982). Its upper surface acts as the soil surface for vascular plants, and it has a matrix of *Sphagnum* shoots bound together by live roots. The structure has been likened to “a mattress constructed by intruding foam into a matrix of wire springs, the foam being coarser above while the springs are weaker below” (Ingram, 1992), and is important in that it enables the mire surface to bear loads and provides structural coherence.

Overloading of the acrotelm can result in catastrophic failure. There are numerous historical accounts of so-called “bog bursts” in Britain and Ireland. A more recent event at la Vraconnaz in Switzerland is documented by Feldmeyer-Christie and Mulhauser (1994) and peat slides were recorded in the uplands of southern Scotland and northern England in 1983; the mechanisms involved in the latter are considered by Carling (1986). These events appear to occur naturally during intense rainfall. At Blantyre Muir in southwest Scotland, a similar failure appears to have been induced by intense drainage of one side of the mire during opencast mining work (Bragg et al., 1991). At Loch nam Learga, on the Isle of Lewis, slippage of peat breached the peat dam retaining the lake waters, resulting in catastrophic discharge (Bowes, 1960).

2.3. *Peat formation and degradation*

Plant growth, death and the aerobic decay which forms peat all occur within the acrotelm, and can be seen in “snapshot view” in a vertical profile (Ingram and Bragg, 1984; Bragg, 1989). Peat formation is a dynamic process, involving upward growth of the *Sphagnum* carpet which buries older material. The latter dies and its decomposition is influenced by the period and depth of air penetration to the subsurface layers, which is in turn related to the fluctuations of the water table.

The production/decomposition balance of the acrotelm has the capacity to adjust to changes in climatic wetness — for example, by a deepening of the acrotelm to produce well decomposed layers of peat in dry periods. Again, such effects tend to ensure long-term stability of the mire system.

However, there is slow anaerobic decay of peat within the catotelm. Therefore, in order to maintain the existing depth of peat, the production/decomposition balance for the acrotelm must always be positive (Clymo, 1984, 1992). If a negative balance for the whole profile should arise, for example by reduced growth (or loss) of vegetation or by excessive lowering of the average water table, the peat deposit will suffer degradation.

2.4. Hydrology

The structure of the acrotelm resulting from these growth and decay processes gives it special hydraulic properties that tend to stabilise the fluctuations of the water table. As the water table rises in response to rainfall, it enters layers of material which are increasingly permeable so that lateral subsurface runoff increases. Thus, further rise of the water table is limited and erosive overland flow seldom occurs. Conversely, should the water table fall into the deeper, more decomposed part of the acrotelm, lateral runoff is impeded because permeability declines rapidly with increasing humification of the matrix, limiting the amount of further water table lowering (Ingram and Bragg, 1984). The result is that the water table spends most of the year within a layer approximately 100 mm thick, with occasional drawdown to around 0.5 m below the surface (Ingram, 1987).

3. Demonstrations of sensitivity

Blanket mire landscapes are extremely sensitive landscapes, with sensitivity manifested either as vegetation change or as erosion of the peat mass. The intrinsic sensitivity of the bog vegetation to environmental change can be demonstrated both from observations of the plant remains preserved in the **peat stratigraphy** (an expression of long-term climatic change), and from **manipulation** of management practices. The following examples of sensitivity are selected from across the wide range of variation of blanket mires in Britain (10° of latitude; from sea-level to 1070 m altitude); because of this wide geographical and altitudinal range, the management issues raised will inevitably differ in detail from place to place.

3.1. Peat-stratigraphic studies

Responses of the bog vegetation to long-term climatic change are often recorded in the peat stratigraphy, as variations in the preserved plant and animal remains and in their degree of humification. There is increasing evidence (Tallis, 1998a) that the vegetation of blanket mire surfaces in the past has varied between a general tree cover (when Scots pine (*Pinus sylvestris*), birch (*Betula* spp.) and other trees grew widely on the bog surface), dominance of heather (*C. vulgaris*) and other dwarf shrubs, dominance of bog moss (*Sphagnum*), and widespread presence of the moss *Racomitrium lanuginosum*. Thus, variations with depth in the degree of humification (Rowell and Turner, 1985; Blackford and Chambers, 1991, 1995; Ellis, 1999), and in the abundance of *Sphagnum* and *Racomitrium* leaves and *Empetrum* pollen (Moore, 1977; Bostock, 1980; Chambers, 1982; Molloy and O'Connell, 1995; Tallis, 1995; Barber et al., 1999; Ellis, 1999) have been shown to occur in a range of blanket peat profiles. An example from a blanket mire in County Mayo, western Ireland, in an extreme oceanic climate where the vegetation might be expected to be relatively unresponsive to climatic change, is shown in Fig. 1.

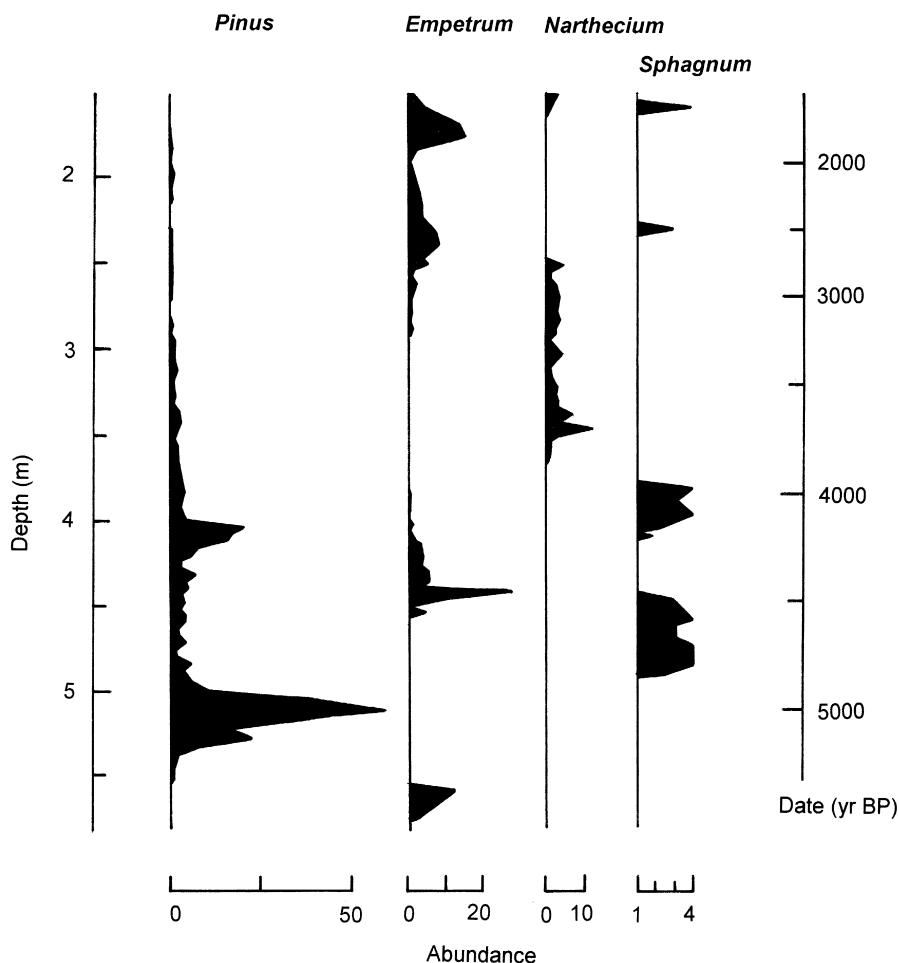


Fig. 1. The abundance of selected pollen types (*Pinus*, *Empetrum* and *Narthecium*) and macrofossils (*Sphagnum* leaves) in the peat column at Glenulra, County Mayo, between ca. 1800 and 5500 years BP. The pollen values of *Pinus* are expressed as percentage of total pollen of non-bog taxa, those of *Narthecium* and *Empetrum* as percentage of total pollen of bog + heath taxa; abundance of *Sphagnum* leaves is expressed on a 4-point scale. Re-drawn from Molloy and O'Connell (1995).

3.2. Manipulation of management practices

Blanket mires cover substantial areas of northern and western Britain, and consequently represent an important economic resource, which has been exploited since prehistoric times (Tallis, 1998a): for seasonal hunting of wild animals (by prehistoric hunter-gatherer peoples); for low-intensity grazing of cattle, sheep and goats, and for limited peat extraction as domestic fuel (up until at least the 16th century); for year-round sheep grazing, game stocking (red grouse and red deer), and water catchment (within the last 200 years); and for plantation forestry, military training, recreation, peat

extraction and conservation (within the last 50 years). Blanket mires are thus **managed** ecosystems, with a long tradition of manipulation of the vegetation. Grazing, burning and drainage are currently practised very widely on blanket mires. Crude estimates suggest that of the 22,500 km² of blanket mire in the British Isles, at least 18,500 km² (82%) is substantially modified as a result of management (Tallis, 1998a).

The response of the blanket mire system to management is a complex of effects (Hulme and Birnie, 1997): the differential sensitivity of individual plant species to grazing, burning, drainage and also nutrient-enrichment (from plant ash and animal dung); the changes in hydrological behaviour of the acrotelm brought about by compaction (MacGowan and Doyle, 1997), deposition of bitumens, tars and ash in the pore spaces following combustion (Mallik et al., 1984; Stoneman and Brooks, 1997), and changed microbial activity (Stoneman and Brooks, 1997); the changes in surface microtopography resulting from trampling and drainage; and an altered microclimate (Fullen, 1983). Because of the wide variation in floristic composition of the bog vegetation across the British Isles (Tallis, 1998a), the detailed pattern of response to management is variable. However, in general, heavy grazing and/or high-frequency burning favours a predominance of graminoids (*Eriophorum vaginatum*, *Molinia caerulea*, *Trichophorum cespitosum*) in the vegetation, whilst low-frequency burning favours a predominance of dwarf shrubs (particularly *C. vulgaris* and *Empetrum* spp.). A *Sphagnum*-rich bog vegetation — in conservation terms the most desirable plant cover — may be the product of centuries of a combination of low-intensity grazing and infrequent burning (Fig. 2; Lance, 1983; Rawes, 1983; Hobbs, 1984; Grant et al., 1985; Shaw et al., 1997).

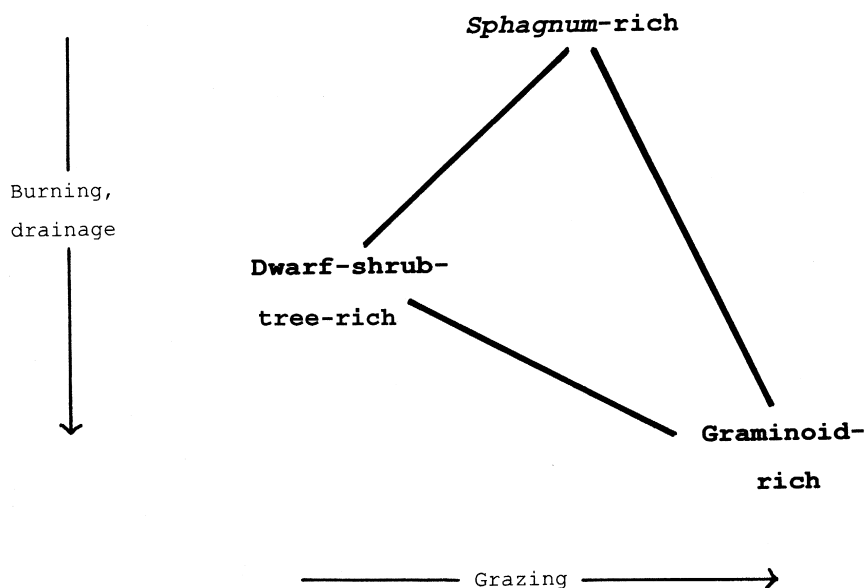


Fig. 2. Generalised responses of blanket mire vegetation to grazing, burning and drainage.

At Coom Rigg Moss, Northumbria, changes in the bog vegetation between 1958 and 1986 were attributed to the cessation of grazing and burning following nearby afforestation (Chapman and Rose, 1991; Charman and Smith, 1992). A relatively uniform *Sphagnum*-dominated plant cover over most of the Moss in 1958 had been transformed by 1986 into one dominated variously by *E. vaginatum* (on the deepest peat areas), *Deschampsia flexuosa* (on the shallow marginal peats), and *C. vulgaris* (on the intermediate areas). Many typical blanket mire species had declined substantially in abundance, or even become extinct, over the 28-year period (Table 2). However, there was no evidence of the scrub development which has been associated with recent cessation of grazing and burning on lowland raised mires (Ingram, 1997). Nevertheless, spread of trees onto ungrazed and unburnt mire surfaces from nearby conifer plantations has become a problem on the low-altitude blanket mires of the Flow Country, Northern Scotland (Lindsay et al., 1988), and tree growth following removal of grazing has been reported even from the high-altitude blanket mires of the northern Pennines (Gore and Godfrey, 1981).

Unsympathetic management by over-grazing and/or over-burning can lead to a reduced plant cover and the exposure of bare peat. At sites in Shetland (Birnie and Hulme, 1990), Connemara (McKee and Sheehy Skeffington, 1997; O'Connor and Sheehy Skeffington, 1997) and the Peak District (Anderson and Radford, 1994), rapid break-up of the blanket mire vegetation and exposure of bare peat is currently occurring at sheep stocking levels of 1.7, 2.0 and 2.5 sheep/ha, respectively. In fact, stocking levels above 1 sheep/ha need careful vigilance. The recurrent exposure of bare peat by frequent controlled burning leads some moor managers to believe that fire should not be used at all as a management tool for blanket bog (Shaw et al., 1997).

3.3. Peat erosion

Once bare peat is exposed, additional factors have to be considered (Fig. 3). A variety of studies has demonstrated the ease with which bare peat can be adversely affected by

Table 2
Changes in abundance of selected plant species (as % frequency at 36 sampling points) at Coom Rigg, Northumbria, between 1958 and 1986 (Chapman and Rose 1991)

	1958	1986
<i>Drosera rotundifolia</i>	55	4
<i>D. anglica</i>	?	0
<i>Erica tetralix</i>	87	61
<i>Eriophorum angustifolium</i>	75	43
<i>Narthecium ossifragum</i>	72	35
<i>S. capillifolium</i>	62	22
<i>S. imbricatum</i>	?	0
<i>S. magellanicum</i>	63	17
<i>S. papillosum</i>	85	37
<i>S. tenellum</i>	55	32
<i>Odontoschisma sphagni</i>	47	12

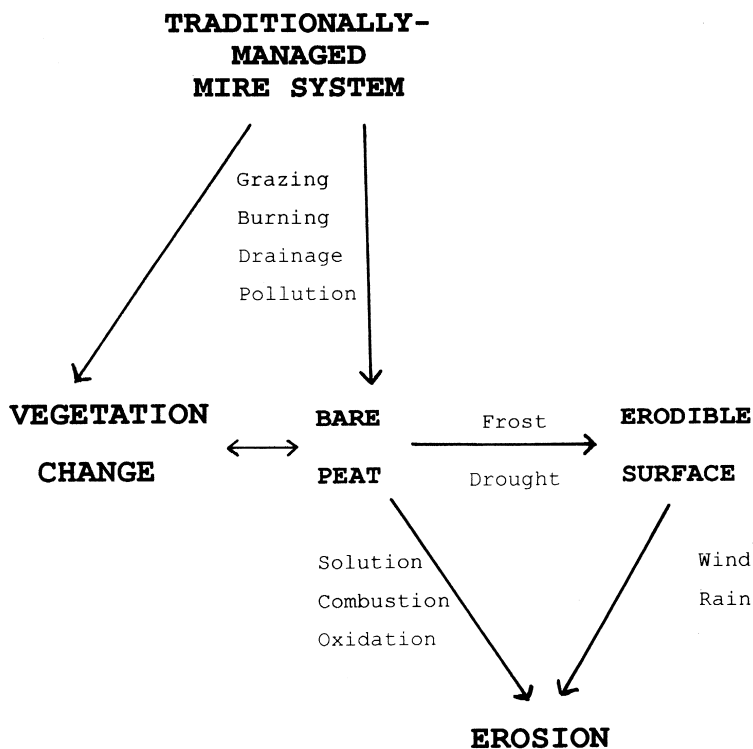


Fig. 3. The sensitivity of the blanket mire system to environmental factors. The system is envisaged as susceptible to both vegetation change and erosion, and the likely roles of the various contributory factors are indicated.

natural weather events. The uppermost region of a peat mass unprotected by a plant cover gradually loses its structural cohesiveness through frost action and desiccation (Tallis, 1973; Tallis and Yalden, 1983; Fullen, 1983; Hulme and Blyth, 1985; Francis, 1990), to produce a superficial scree 6–20 cm deep, of loosely-textured and finely-particulate material. Unless compacted by trampling, this scree is readily degradable by wind (Radley, 1962; Evans, 1989; Francis, 1990), rainwash (Tallis, 1973; Crisp and Robson, 1979; Francis, 1990; Labadz et al., 1991; Burt et al., 1997) and biochemical oxidation (Francis, 1990). Rain may also penetrate deep into the peat mass down desiccation cracks (Bowes, 1960; Francis, 1990). Peat can be lost at rates of up to 5 cm/year (Tallis, 1998a), either from the whole surface or along lines of preferred water flow — which gradually become incised to form the gully systems characteristic of massively eroding blanket peat (Osvald, 1949; Bower, 1960). A conservative estimate of the extent of blanket peat in the British Isles affected by erosion is 350,000 ha (Tallis, 1998a).

That erosion ranges from local or more extensive degeneration of the plant cover, and associated limited exposure of bare peat, through development of gully systems, to massive removal of the peat blanket. Some gully systems are thought to have originated

from the linkage and drainage of pool systems (Bower, 1960; Tallis and Livett, 1994), a process which can be seen occurring in some areas (Bostock, 1980; Boatman, 1983). The drainage and subsequent erosion of a pool system in this way requires both a progressive breakdown of the baulks between adjacent pools and an outlet for the pool waters. Breakdown of the baulks may result from trampling by, e.g. red deer, or from wind-generated wave action, but coalescence of pools could also occur following a long-term change to a wetter climate, with rising water levels in the pools. The initial drainage outlet may be a subsurface pipe (Bostock, 1980; Lindsay et al., 1988), or headstream extension upslope following forest clearance (Tallis, 1998a).

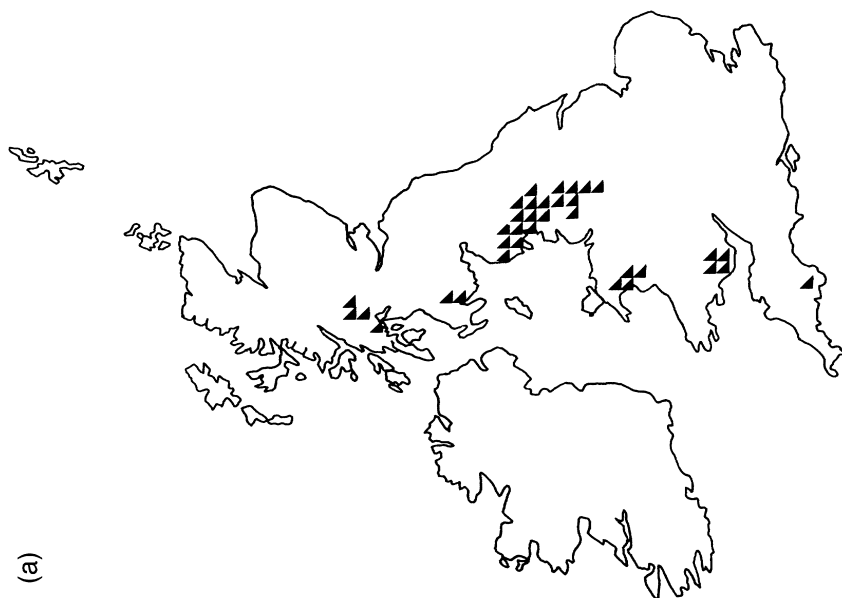
Other gully systems, developed on sloping ground, result from a fundamental change in the hydrology of the peat mass, whereby the lateral transport of excess water towards the peat margins through the permeable acrotelm is replaced, in part or in whole, by transport over the bog surface. The possible instigators of such gully erosion are diverse (Tallis, 1998a):

- (a) reduced permeability of the acrotelm, as a result of compaction by trampling, or blockage of the peat pores by the fine particles produced by burning;
- (b) the formation of an impermeable skin to the acrotelm, by prolonged drought or fire;
- (c) loss of the acrotelm, by erosion or biochemical oxidation; and
- (d) long-term raising of the water table in the peat mass (for example, by climatic change), thereby reducing the effective depth of the acrotelm.

As regards peat erosion, the most extensively studied region is the Southern Pennines — admittedly an unusual landscape, developed under a ‘marginal’ climate and intense human impact (Tallis, 1997b), but one which illustrates the complexity of the erosion patterns visible at the present day. Some erosion is obviously recent, the result of overgrazing, perhaps in association with incautious moor-burning, and is governed by documented changes in land use (Tallis, 1998b). Other dateable erosion events relate to major wildfires during prolonged periods of drought (Anderson et al., 1997), and to the loss of *Sphagnum* from air pollution (Ferguson et al., 1978; Press et al., 1986; Lee et al., 1993; Woodin and Farmer, 1993). In a sense, these are one-off events, with little chance of recovery of the blanket mire vegetation in the Southern Pennines with current stocking rates and climate (Anderson et al., 1997), but the occurrence of carbonised material in the peat suggests that burning at least has been a regular feature over several thousand years. Thus, at Alport Moor, fifteen bands of carbonised material were traced across an 8-m long peat profile spanning the last 2800 years (Tallis and Livett, 1994).

Several lines of evidence certainly point towards human involvement in the peat erosion process; that peat erosion is negligible below an established plant cover (Imeson, 1971, 1974; Butcher, 1989); that bare peat, by contrast, is readily erodible; and that bare

Fig. 4. (a) Moorland areas in the British Isles most at risk from the combined effects of sulphur and nitrogen (20×20 km grid squares) (re-drawn from Woodin and Farmer, 1993); (b) areas of blanket peat where severe peat erosion has been recorded (Tallis 1998a).



peat is associated with, and results from, poor management practices. Extensive areas of currently eroding peat which can confidently be attributed to human mismanagement occur in, for example, the Southern Pennines (Anderson et al., 1997), the North York Moors (Maltby, 1980), Dartmoor (Ward et al., 1972) and western Ireland (O'Connor and Sheehy Skeffington, 1997). For other areas of damaged blanket mire the causes are less clear: by analogy with the Southern Pennines, air pollution has been suggested as a possible cause for the break-up of bog vegetation that is occurring in parts of Wales (Yeo, 1997). The incidence and severity of erosion increases with altitude, and examples of high-level plateaux showing massive peat erosion are recorded from Ireland (Osvald, 1949), Scotland (Lindsay, 1995), Wales (Yeo, 1997) and England (Osvald, 1949; Bower, 1961). In extreme cases the peat cover may be almost entirely lost over large areas (Kertland, 1928; Turner, 1984). The positive correlation between altitude and severity of gully erosion suggests that climatic factors, and particularly wind and frost action (Osvald, 1949), may also be involved.

There is increasing evidence, however, that many of the gully systems in British blanket peats are several hundred years old, and thus may pre-date intensive human exploitation (Tallis, 1998a). In the Southern Pennines, inception of gully systems has been linked to the dry conditions of the Early Mediaeval Warm Period, ca. AD 1100–1250 (Tallis, 1995, 1997a). Rhodes and Stevenson (1997) examined peat input to the sediments of seven small lakes with extensive peat-covered catchments at sites in Scotland, Ireland and Wales. They found evidence of enhanced peat erosion at six of the seven sites between AD 1530 and 1690, and speculated that the well-documented harsher and wetter conditions of the so-called Little Ice Age (ca. AD 1500–1850) were responsible. A purely natural origin for gully systems in peat thus cannot be ruled out.

Extensive areas of eroded blanket peat occur beyond the limits of the areas affected by rapid population growth in the last 250 years (as measured by current air pollution levels — Fig. 4). Moreover, evidence of burning (perhaps indicative of human utilisation of the blanket mire vegetation for grazing) occurs sporadically throughout many blanket peat profiles (Tallis and Livett, 1994; Ellis, 1999), though the levels of charcoal generally rise within the last 500–750 years (Rhodes and Stevenson, 1997). The likely timing of the onset of peat erosion (see above) means that we cannot rule out grazing and burning as contributory causes of the peat erosion, but it is clear that much gully erosion pre-dates the period of more intensive utilisation of the upland resources in the last 200 years. Moreover, the actual process of peat erosion is a purely natural one, brought about by the action of frost, water, wind and desiccation.

4. Conclusion

The phenomenon of peat erosion appears, thus, to be a response of the blanket mire system to heightened levels of environmental perturbation of any kind, and the ultimate expression of the sensitivity of blanket mire landscapes to environmental change. In the southern Pennines, intensification of grazing and burning are clearly implicated as contributing factors to erosion under the marginal climatic conditions at the edge of the blanket mire distribution range. However, in many blanket mire regions of Britain,

including the southern Pennines, current management trends are towards reduced stocking levels and less intensive burning (Anderson et al., 1997), and the issues of reduced conservation value of the blanket mire surface following spread of dwarf shrubs, and even scrub and tree growth, may have to be faced. The problems for blanket mires raised by global warming will similarly have to be addressed urgently — and since our understanding of the mechanisms by which the stability of ombrogenous mire ecosystems is maintained underlines the likelihood of heightened sensitivity during times of climate change, it would seem particularly important to seriously address the design and implementation of sustainable management regimes for our remaining blanket peat landscapes.

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