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Short-term changes in upland soil erosion in England and Wales: 1999 to 2002

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Abstract

Erosion was assessed on upland sites between October 2001 and June 2002, and compared with measurements of erosion made at the same sites during previous visits (1999). In addition to highlighting the scale of changes in erosion extent and nature over the sample period, the data were used to determine the influence of field site management and weather conditions on upland erosion. Results indicated that site erosion continued over the duration of the study, with most upland regions of England and Wales experiencing increases in erosion area and volume. On 52% of the 139 sites surveyed, increases in erosion extent resulted in 705 m^2 of newly exposed soil. Sheep were identified as the most frequent cause of this increased erosion, although the impacts of humans (through vehicle access, footpaths and drainage) were also extensive. Water-driven erosion processes were also prevalent in the maintenance of bare soil, both alone and in combination with other factors such as sheep, walkers and general weather conditions. Revegetation of bare soil was also an important feature of upland sites, resulting in a net decrease in erosion area on 63% of sites. The implications of these changes in erosion are discussed in the light of continuing changes in land use and management in the UK uplands, particularly those of reform of the EU Common Agricultural Policy (CAP), and in view of predicted changes in climate.

Keywords: Upland soil erosion; England and Wales

1. Introduction

The uplands of England and Wales are an ecological, cultural and political region defined by the underlying soils, climate and centuries of farming (Bunce, 1987). Although dominated by mixed deciduous and pine forests until 5000 years ago (Evans, 1975; Rackham, 1976), the uplands were gradually cleared for hunting and agriculture (Macklin et al., 2000), resulting in permanent grasslands and expansion of heath (Hester, 1996) in an increasingly agricultural and pastoral country (Tansley, 1949). Sheep farming, first promoted in the 12th century (Orr, 2000), has continued to the present day, to culminate in a virtual monoculture underpinned by farm subsidies (Phillips et al., 1981; Harvey, 1997; Environment Agency (EA), 1999). In addition to their agricultural worth, however, uplands are important for nature conservation, recreation, archaeology and field sports (Thompson et al., 1995; Department of the Environment, Food and Rural Affairs (DEFRA), 2004a; Rodway-Dyer, 2004), represent national reserves of biodiversity, and are economically necessary for the provision of water supplies, military training grounds

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and forestry production (Evans, 1996; McHugh, 2000). In addition, peatlands, the majority of which fall within upland landscapes, represent a vast store of carbon approaching one third of the global carbon stock (Gorham, 1991; Jenkinson et al., 1991). Protection of the upland soil resource is, therefore, important.

Upland soils in a fully vegetated state are relatively resistant to erosion but susceptibility to erosion increases with vegetation removal (Evans, 1996), traffic (Harrod, 1979) and cultivation (Harrod, 1998) and, hence, is largely a function of land use and water movement. Currently there is concern that excessive areas of the uplands are eroded or at risk of erosion because of the sensitivity of this marginal environment to intense agriculture and recreational use (Evans, 1990a; Morgan, 1995; Scottish Environment Protection Agency (SEPA), 2004). In Scotland, examination of erosion extent in aerial photographs taken in 1998–1999 revealed that the most severely eroded areas were characterised by grazing, burning and vehicle tracks (Grieve et al., 1995). Elsewhere, long-term studies in the Peak District by Evans (1977, 1990b) established the important role of grazers in upland erosion while McHugh (2000) identified water and grazing animals as the principal forces responsible for upland erosion across England and Wales in 1999. Other studies have shown the role of recreation in creating and maintaining erosion (Rodway-Dyer, 2004; SEPA, 2004). The erosional impacts of wind (Warburton, 2003), frost (Bryan, 2000) and rainsplash (Morgan, 1995) on exposed soil are also well known.

Such soil erosion represents a threat to the productivity, biodiversity and aesthetic appeal of upland ecosystems. Once mobilised, eroded soil particles also represent a significant environmental and safety concern. As well as the economic costs of dredging or clearing, deposition within watercourses, reservoirs and the coastal zone compromises fish stocks, threatens water quality with sediment, nutrients and pathogens, and increases flooding risk (Butcher et al., 1992; Evans, 1996; Meteorological Office, 2000; DEFRA, 2004a). Additional problems associated with upland degradation include the release of CO_2 from peatlands, associated with desiccation of peat during droughts or when peat integrity is compromised (Bellamy et al., 2005; Freeman et al., 2004), and the discolouration of water due to dissolved organic compounds from degraded peat (Naden and Watts, 2002). As the forces of weather act on all exposed soil to promote and perpetuate the erosion and mobilisation of soil particles, these impacts of erosion may be expected to increase under conditions of climate change. In the UK, climate change is predicted to result in increased annual rainfall and a higher frequency of more intense rainfall (Meteorological Office, 2000), particularly in winter (Meteorological Office, 2002).

In spite of this importance, monitoring of soil erosion within upland habitats has been limited in both scale and time, and there has been little opportunity to examine change in erosion with time. This study attempted to address this limitation through repeat monitoring of upland sites and assessment of the scale and causes of change in erosion on those sites.

2. Methods

2.1. Site selection

Between 1997 and 1999, a survey was conducted to assess soil erosion extent within upland areas of England and Wales (McHugh, 2000). The uplands were defined as unenclosed grassland or heathland, or of bog above 200 m altitude. Within this area, 399 sites, objectively located at 5 km intervals on an orthogonal grid and each centred on an intersection of the Ordnance Survey UK grid of eastings and northings, were surveyed. Each site comprised a circle of 50 m radius, within which vegetation, management and slope were described, as were the dimensions, form and causes of any exposed soil in evidence. Such erosion was assessed on 206 sites, and predominantly occurred as footpaths, animal and vehicle tracks, drains, sheep scars, poached areas and burnt areas (McHugh et al., 2002). With the exception of forested sites, which were excluded because of the logistical difficulties in accessing the grid reference for survey, no sites (and hence, no erosion) were either selected or omitted for study.

Between October 2001 and June 2002, 139 of those eroded sites were revisited and resurveyed to assess changes in the extent of bare soil: access to the remaining 67 sites was prevented by the ongoing Foot and Mouth Disease (FMD) crisis. Access details (such as Ordnance Survey (OS) map, parking grid reference, route taken, etc.) and photographs taken during previous site visits were used in combination with a Geographical Positioning System (GPS) to ensure that each exact site was revisited.

2.2. Site resurvey

Evidence of change in site management was provided by comparing photographs of the site on previous visits with its current appearance. Details of vegetation composition, form, height and condition, numbers and types of grazers present, and evidence of grazing animal poaching, dunging or topiary, were recorded for