Upland Hydrology Group

The hydrology of non-peat soils

December 2014

Introduction

Over the last few years the science and management of peatlands has been subject to intense research effort. Thanks in part to the knowledge exchange activities of the Upland Hydrology Group, the IUCN Peatland Programme and others the debate about how these areas should be managed is better informed and has moved forward.

A substantial proportion of the UK uplands are not however dominated by peat. These areas are poorly understood not least in terms of the hydrological and water quality impact they exert downstream, and require significant research investment. This briefing note draws on discussions at a meeting of the Upland Hydrology Group held in Leeds on 30th October 2014.

Upland soils

There is no simple definition of 'uplands' as a whole. For the purposes of this note, uplands are areas of higher ground encompassing mountain, moor and heath together with associated in-bye land.[1] They include land dominated by blanket bog, dry and wet dwarf shrub heath, rough grassland, areas of semi-improved and improved grassland, and woodland.

The uplands cover c. 2.2 million ha (17%) of England, with a roughly even split between land covered by peat soils and land covered by non-peat soils. The non-peat soils can be described as "organo-mineral soils"[2] which:

- Often (but not always) have peaty surface horizon
- May have organic-rich mineral horizons
- Vary in their hydrological properties, as a result of differences in soil texture and in particular the amount of clay they contain.

Rough grasslands and most conifer woodlands are generally associated with soils with a peaty surface above less well-draining gleyed sub-soils. Improved and semi-improved grasslands are associated with soils which are less rich in peat and with a tendency to be seasonally waterlogged. Broadleaved woodland is often located on steeper slopes with better drained but shallower soils.

A naïve view of the landscape shown in the photo below is that the slopes we can see are covered by non-peat soils and that peat will be found on the moorland beyond the horizon. The real situation is often far more complex, with significant variation of soil type over just a few metres, pockets of gleyed soil in areas of predominantly peat soils, and no simple correlation between soil type and hillslope, altitude or topography.

This local variation in soil type means different factors come into play in different sites at different times, and adds an additional layer of complexity to our understanding of upland soil processes.

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[1] Non-peat uplands addressed in this note do not include the significant areas of upland limestone found, for example, in the Yorkshire Dales and the Peak District. These areas have completely different hydrology and patterns of land-use.

[2] Predominant soil types here include stagnohumic gleys, stagnohumic podsols and acidic brown earths.

Land management

Livestock farming is the principal driver of land management on organo-mineral soils in the uplands. In economic terms, farming here continues to be highly marginal, and is characterised by consistently low levels of profitability and a high dependency on agricultural and environmental payments.

Forestry is the other main land-use in these areas. As with farming, planting trees is largely dependent on rural development payments. The hydrological benefits of establishing tree cover can include:

- Protecting soil from compaction and surface sealing, improving soil structure and so increasing infiltration
- Trapping sediment, stabilising stream banks and reducing levels of diffuse pollution
- Moderating stream temperature – keeping water cooler in the summer and warmer in the winter
- On some sites, woodland can have an important role in local flood alleviation schemes.

In the wrong place, or if badly managed, forestry can however create soil and water problems, such as acidification, a reduction in water resources and diffuse water pollution. Forest Research has developed opportunity maps to guide where tree planting can be of greatest benefit. These can be applied across a range of scales, from a strategic, national level down to the practical catchment or farm scale.

Some of the benefits we hope to see as a result of forestry can be achieved more effectively in the lowlands or on the floodplain, but targeted and sensitive woodland creation has the potential to deliver water benefits in headwater catchments as well.

Why organo-mineral soils in the uplands matter, and the challenge they present

The organo-mineral soils in the uplands play an important role in the provision of the benefits we gain from the uplands as a whole (including the supply of clean water, a potential contribution to flood risk management, biodiversity, carbon sequestration and storage, food and fibre, and a working and attractive landscape).

In terms of agricultural and biological productivity a lot of these areas can be described as degraded land, which has been subjected to generations of woodland clearance and extractive pastoralism. As a result they support an impoverished flora often dominated by extensive swathes of purple moor grass (*Molinia caerulea*). We need to know how resilient these sites are in their current condition, and ensure as a minimum that we maintain the services we derive from these landscapes. More than this, we need to identify how we can better manage these areas to yield additional benefits. These ambitions need to be achieved in the context of continuing environmental change in general and climate change in particular.

Soil biodiversity in these areas may often be low, and in places the soil itself may be subject to accelerated erosion, is compacted, and infiltration rates are low. These characteristics have an impact on flow and velocity of run-off, add to greenhouse gas emissions through decomposition, and contribute to the amount of dissolved organic carbon found downstream.

What do we need to know?

The headline conclusion from our meeting was how little seems to be known about organo-mineral soils in the uplands, their hydrology and their chemical and physical properties. Basic data is lacking, and soil mapping is woefully inadequate across these areas. Maps are only available at a coarse scale, and often fail to pick up on local variation.

In terms of underpinning science for these areas we need to establish a comprehensive baseline of knowledge about soil chemistry and soil biodiversity, get a better idea of the water and carbon budgets on these sites, and develop models for hydrological flow pathways and velocities. Findings then need to be disseminated to a wide audience.

The impact of different land management regimes on these soils, and the consequences for the full range of ecosystem services, are not well understood and seem likely to vary within a small area and between soil types. Just one example is the effect of managed burning and wildfires on these soils. We need a more detailed understanding of what happens in different situations, including, for example, the impact of different vegetation types, including dwarf shrubs, rough grass and a range of tree species.

In terms of forestry, we have a reasonably good understanding of the impacts of upland conifer plantations on water quantity and quality, but there is uncertainty about how these will respond to climate change and changes in future forestry management. Even greater uncertainty surrounds the impacts of upland broadleaved woodland on soils and water, which have been little studied. A number of woodland creation schemes are underway, such as the Clough Woodland Project in the Peak District (led by Moors for the Future with the National Trust as their key partner) which present opportunities for study.

The new CAP arrangements are still emerging and may not offer all that much either to upland farmers or to the upland environment. Regardless of final arrangements, there is an urgent need for policy relevant evidence which will better inform future plans.

Once we have improved our understanding of the hydrological, soil and ecosystem processes on the non-peat uplands, we will be in a much better position to develop whole catchment solutions which would be more sustainable and could help us reduce flood risk and ensure water bodies are in good ecological condition. We would know where in the uplands we should focus our efforts, and when it might be more effective to implement measures downstream.