Managing upland catchments: priorities for water and habitat conservation

A seminar held on Thursday 10th July 2003, followed by a field trip to Moor House NNR on Friday 11th July 2003.

The seminar was held in the Dawson lecture theatre, Science Site, University of Durham.

Chair: Professor Bill Heal

Introduction, context and seminar conclusions (Abstract)

An introduction to the Water Framework Directive and potential implications for upland catchment management
Dr Chris Uttley, Countryside Council for Wales (Abstract) (Presentation) [pdf, 438kb]

The hydrology of upland UK catchments
Professor Tim Burt, University of Durham (Abstract) (Presentation) [pdf, 848kb]

Carbon and upland peat – causes for concern?
Dr Fred Worrall, University of Durham (Abstract) (Presentation) [pdf, 401kb]

Acidification, forestry and river basin management
Dr Danny Donoghue, University of Durham (Abstract) (Presentation) [pdf, 1.39Mb]

An integrated approach to catchment systems: mineral and organic sediment budgets
Dr Jeff Warburton, University of Durham & Dr Martin Evans, University of Manchester
(Abstract) (Presentation) [pdf, 1.85Mb]

Upland catchment conservation: linking biological and earth sciences
Professor John Gordon & Professor Des Thompson, Scottish Natural Heritage
(Abstract) (Presentation) [pdf, 1.61Mb]

Water resource management
Dr Chris Spray, Northumbrian Water (Abstract) (Presentation) [pdf, 291kb]

Introduction and context

The Joint Nature Conservation Committee (JNCC) led UK Upland Habitat Action Plan Steering Group (UKUHAP SG) identified the importance of bringing researchers, advisers and policy makers together to consider the management of upland catchments. To date there has been little dialogue between the different sectors of research and advice.

This meeting sought to:

- Form linkages between freshwater, terrestrial, biological and geographical approaches to conservation management in the uplands;
- Improve knowledge of upland catchment processes; and
- Provide a firmer understanding of the sort of catchment management needed to support the conservation of biodiversity in the uplands.

More than 70% of UK water supplies is sourced from upland catchments. Yet the hills and uplands have long been subjected to extensive, and periodically intensive, land management (forestry, grouse moors, sheep grazing) with little regard to the consequences for water resources. The emerging **Water Framework Directive** (WFD) has focussed attention on the need for a more holistic approach to catchment management through river basin management plans and the application of an ecosystem approach to enhance habitat quality. The WFD will make significant demands on land and water managers at all levels, and requires recognition that the coastal, estuarine and lower river conditions are significantly influenced by conditions in the headwaters.

Seminar conclusions

1. There are diverse and fragmented institutional interests and responsibilities concerned with the uplands - 30 organisations were represented amongst the 60 participants.

2. The integrity of the upland ecosystems: physical, biological, social and economic factors are intimately and extensively interactive.

3. The sensitivity of these systems to disturbance, particularly infrequent and often localised episodes e.g. an exceptional flood or an outbreak of foot and mouth disease, or clear-felling a forest. Such episodes or events may be localised, but the consequences are often widespread and long-term.

4. Increasing erosion is clearly linked to ‘flash’ floods and periods of drought, which may be becoming more frequent due to climate change.

5. The continuum from upland catchments, through wetlands and lowlands, to estuaries and coastal waters. Water moves downstream until recycled back to the uplands through the atmosphere. Fish migrate up and down the rivers.

6. There is an impressive diversity and depth of data, information and expertise available and relevant to understanding the dynamics of upland catchments in UK.

7. The UK upland peatlands provide an extremely important carbon store and therefore a sink for $C0_2$; this is far larger than that found in the forests of the UK. Modelling has predicted that trends towards increasing loss of carbon through erosion could result in peatlands become a source of $C0_2$ by 2013.

8. Reducing carbon export from upland areas should be clearly incorporated into upland land management. There is a need for researchers, policy makers and land managers to work collaboratively towards developing best practice management for carbon retention, for

example through: grip-blocking; identifying vegetation type/height and related grazing regimes.

9. There is considerable evidence at Moor House NNR of natural re-vegetation ‘healing’ of erosion channels. Further research is need to better understand the triggers to the cycles of erosion and re-vegetation, which can be applied to other upland areas.

10. Increasing demands for water (quality and quantity), emerging changes in climate, growing political pressure for carbon conservation, and the requirements of the Water Framework Directive, combine to highlight the need to integrate existing information into spatially explicit models to examine potential future changes, and how these might be best managed.

11. **Abstracts** and powerpoint **presentations** are available here on the JNCC website. Click on the links beside the talk titles in the above in the table of contents to access. Email addresses for all the speakers are provided in the abstracts. A short summary paper will also be submitted for publication.

12. **Acknowledgments**. We are very grateful to Hatfield College and the Department of Geography, University of Durham for hosting the meeting.

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An introduction to the Water Framework Directive and potential implications for upland catchment management.

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The Water Framework Directive is potentially the most important and innovative piece of environmental legislation the UK has been required to implement to date. As its title suggests it creates a framework for integrating many existing pieces of aquatic legislation and ensuring compliance with those. More interestingly, it shifts aquatic management away from the tradition of setting chemical objective "surrogates" for quality, and requires the UK to set biological and hydro-morphological objectives in addition to chemical standards. It requires the achievement of "good ecological status" for the whole aquatic ecosystem. In creates protection for terrestrial ecosystems dependent upon groundwaters, and requires the integration of the water dependent standards and objectives required for Natura 2000 habitats and species.

The WFD is a proactive piece of environmental legislation, in that it requires the UK to establish aspirational objectives for aquatic ecosystems, and then put in place a programme of measures in order to achieve them. This includes restorative measures. The objectives and measures will be set out in a River Basin Management Plan, which stakeholders and interested parties must be encouraged to contribute to.

Most powerfully, the WFD requires the UK to control diffuse pollution to the extent needed to comply with it, or with any of the other pieces of legislation integrated into its framework. This implies a regulatory control mechanism on a number of land management activities; agriculture, forestry and the land use planning process being the obvious candidates for further controls.

It is this element that will arguably have the greatest potential impact on upland catchments. Measures to control erosion of sediments from upland farms may well be required. Changes in upland forestry practice and riparian habitat management may be needed to reduce peak flows, reduce erosion or limit the effects of acidifcation. There may be extra pressure for liming of upland areas to reduce the effects of acidification.

The WFD extends legal protection for the first time to upland tributaries, headwaters and some lakes. They will be required to meet whatever ecological objectives are established for them.

The status of peatlands in the WFD is still uncertain. If they depend upon surface waters or groundwater aquifers for water supply, this will offer some protection since these water bodies will come under the protection of the WFD. Peatlands that are also N2K sites will be required to achieve any water related standards and objectives, including those concerned with maintaining saturation or reducing drainage.

The WFD will play a huge contribution to furthering protection of aquatic ecosystems, by raising general quality and ensuring biological and morphological objectives are met. It also has potential benefits for groundwater dependent terrestrial ecosystems. Water dependent N2K sites potentially benefit most through the need to include their requirements in the programme of measures.

To take advantage of the WFD and get most benefits from it, colleagues working in the uplands need to outline clearly where water is an important factor in protection of the relevant habitats and species, and need to start outlining which changes to upland management activities will have the most beneficial impacts on aquatic systems and upland biodiversity.

Links to further information about the WFD:
www.environment-agency.gov.uk
www.sepa.org.uk
www.sniffer.org.uk

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The hydrology of upland UK catchments

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This presentation reviewed the essential aspects of upland hydrology in the UK. The combination of high rainfall and low evaporation results in large volumes of stream runoff. In most places, rocks are impermeable while soils are thin or have waterlogged, peaty characteristics; this combination means that the runoff regime is invariably 'flashy' with high flood discharge and low baseflow.

The presentation comprised four sections:

Analysis of patterns of streamflow in upland areas
Consideration of climatic controls on the hydrological regime
Description of runoff process mechanisms
Reflection on long-term hydrological changes, both natural and human-induced.

Underpinning the whole presentation was the concept of the drainage basin as an integrated system, emphasising in particular the links between hillslope runoff processes and channel response. This forms the basis for understanding both water quality variations in upland basins, and the integrated management of upland catchment systems.

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Carbon and upland peat – causes for concern?

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As part of the Kyoto Protocol developed countries are committed to reducing greenhouse gases by 2012 to an average of 5% below their respective 1990 levels. At the Sixth Conference of the United Nations Framework Convention on Climate Change, 2001, it was agreed that countries could use carbon sequestration resulting from human induced activities since 1990 on grazing land, by crop land revegetation, or by forest management to help meet reduction targets. This means that there is an increased imperative to understand carbon dynamics of these land uses.

In the UK, peatlands are the most significant wetland environment and the largest terrestrial carbon pool in the country. The majority of upland peat is grazed, and as such come under the land that could be used to meet reduction targets. However, there is growing evidence that as the UK climate changes peatlands will shift from net sinks to net sources of carbon. This presentation: outlined the evidence for this shift; explored the controls upon carbon release; and suggested possible remediation strategies.

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Acidification, forestry and river basin management

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This paper explained the causes of acidity in the environment, both naturally occurring and from anthropogenic sources. It then went on to look at the evidence pointing to conifer afforestation, which is a common land use in the British uplands, the impacting upon the process of acidification.

A case study was presented from Galloway in SW Scotland, which is a region with naturally acidic geology, soils and vegetation. Parts of Galloway are heavily afforested and the fisheries community in particular has experienced a loss of suitable habitat for salmonids with the acidifying effect of non-native conifer plantation forestry. We investigated the regional relationships between high flow water chemistry, juvenile salmonid populations and conifer forest cover in 91 streams spread over an area of approximately 2000 km^2 in Galloway. The results clearly suggest that catchment afforestation has a detrimental impact on salmonid populations probably because conifer plantations exacerbate surface water acidification, resulting in water chemistry characteristics which are toxic to juvenile salmonid survival.

The implication of these findings is that appropriate management strategies should be sought in order that forestry and fisheries can co-exist in upland Britain. The paper looked at recent developments which might assist with the difficult task of river basin management in chemically sensitive catchment areas.

*Keywords: A*cidification; Conifer plantations; salmonids;

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An integrated approach to catchment systems: mineral and organic sediment budget studies

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The movement of water and sediment in upland catchments is closely related. Rapid erosion and high sediment yields are often associated with periods of rainfall and high run-off. Evaluating the importance of such events and the cumulative significance of slower and less dramatic geomorphic processes can only be assessed if a systematic evaluation of sediment, production transfer and storage in upland catchments is undertaken.

An excellent tool for analysing upland sediment systems involves the construction of sediment budget models. Sediment budget models aim to recognise and quantify sediment production, storage and transport from sources within a catchment to eventual sediment loss at the exit from the drainage basin. In a UK upland context a basic division can be recognised between mineral sediment systems typical of mountain relief and organic-mineral sediment systems more typical of blanket peat moorland.

This presentation outlined the fundamental principles of constructing upland sediment budgets, and illustrated the advantages of this approach for upland catchment management using five topics:

1. Contrasts between mineral sediment systems and organic-mineral sediment systems;
2. Local floods in the uplands – Catcleugh, August 2002, Moor House, July 2002 ;
3. Longer-term perspectives on sediment delivery;
4. Stopping erosion of peatland gullies – lessons from sediment budgets; and
5. Benefits of sediment budgets for understanding upland erosion and sediment dynamics

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Upland catchment conservation: linking biological and earth sciences

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1. This talk developed collaborative work between biologists and earth scientists in Scotland, Sweden and the Czech Republic. At the centre of this is work to understand the nature of change in mountain soils, habitats and landscapes.

2. Close dependencies exist between geodiversity and biodiversity at different spatial scales in mountains. At a broad scale, habitat distributions reflect long-term geological and geomorphological evolution of the landscape and interactions with past and present climates. At a local scale, there is a close, functional interplay between landform, soils, geomorphological processes and climate.

3. Biodiversity is also a function of changes in climate and geomorphological processes over different time scales. Over longer time scales, patterns of Quaternary glaciation and distributions of refuges have played an important role in accounting for present-day biodiversity. Over shorter timescales, there are functional links between biodiversity and current geomorphological processes, for example in maintaining dynamic environments and geomorphological heterogeneity.

4. Extreme episodic events play a significant role in maintaining geomorphological heterogeneity and habitat diversity.

5. More empirical and, indeed, experimental data are required to predict landscape sensitivity and the potential for irreversible changes.

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Water Resource Management

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This presentation outlined the complexity of providing high quality water supplies for human use and consumption.

Upland catchment management is vital to the supply of water, and involves many stakeholders.

However, water suppliers at present deal with problems such as: catchment run off; bankside erosion; and effluent (agricultural/industrial/domestic) through end of pipe methods, at great cost to the tax-payer. Management practices upstream could considerably reduce these costs.

The talk considered the upland catchment management methods, such as moor gripping, to control water colour in a project in the Pennine Uplands and Tees Valley.

The potential benefits of sustainable catchment management with a stakeholder led partnership were identified, to overcome the considerable challenges.

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