

Fresh waters and climate change in Scotland

Fresh waters of Scotland

The fresh waters of Scotland are world-renowned for their abundance, scenic quality, cleanliness and wildlife.

Northern and western areas are drained by numerous small, steep coastal rivers, with larger slower rivers in the south and east. Standing water bodies are also very diverse, ranging from the small, peaty upland lochans to richly vegetated lowland lochs, and the dark, cold depths (310 m) of Loch Morar, one of the deepest fresh waters in Europe. In lowland areas, rich fen and raised bog wetlands add to the diversity of freshwater systems. This great variety of Scotland's fresh waters and associated wetlands reflects Scotland's topography, geology, climate and human activity.



The fresh waters of Scotland include some of the most spectacular waters in the UK as well as the largest:

- Loch Lomond (greatest area: 71 km²),
- Loch Awe (longest: 41 km), and
- Loch Ness (greatest volume: 7452 x 10⁶ m³).
- The River Tay is the largest river by flow (194 m³ s⁻¹).

Data source: Maitland, P. S., Boon, P. J. and McLusky, D. S. (eds.) (1994) *The fresh waters of Scotland. A national resource of international significance*. John Wiley and Sons, Chichester.



Networks of rivers, burns, lochs and pools are distinctive and much-loved features of Scottish landscapes. Scotland is one of the strongholds of several freshwater species which have declined or even disappeared in many other countries; for example, freshwater pearl mussel, Arctic charr, Atlantic salmon and otter. Wetland systems contain distinctive stands of wet woodland, rushes, reeds, and sponge-like *Sphagnum* mosses. Fresh waters support a range of recreational activities,

including angling and kayaking and canoeing, while the water's edge provides an attractive setting for walking and picnicking. Fresh waters also meet a variety of other human needs, including water supply, waste disposal, and water for the food and drink industry, farmland irrigation, and farmed fish.

Climate change in Scotland

A study of Scottish climate changes between 1914 and 2004 found that temperatures had increased in every season and in all parts of Scotland since 1961. Scotland had also become wetter since 1961. In winter in the north and west heavy rainfall events had increased significantly, with an average of rainfall increase of almost 60%.

UK Climate Projections 2009 indicate that by the 2080s Scotland will be warmer than now, especially in summer. Snowless winters may become the norm in some parts. Winters will be become wetter than they are now. Summers will become generally drier, but not all of Scotland will be affected in the same way, so different areas may face different problems. There may only be a slight reduction in rainfall in the north-west but as much as a 40 per cent reduction in the south and east. The overall climate will become more unpredictable with more frequent and more extreme weather events, such as heavy rainfall, drought and high winds.

Impacts on fresh waters

Impacts of climate change on the water cycle are expected to be significant. These changes are already happening. Over the past 15 years flooding has become an increasing occurrence over Scotland. Increased rainfall, especially from more frequent storms and more rapid snow melt in the hills, has increased the quantity and so velocity and power of water in rivers. For example there has been a 40% increase in maximum winter river flow in the River Teith over the last 40 years.

Flash floods are a serious threat to the increasingly rare freshwater pearl mussel. Spawning beds of salmon may be washed out too. Such floods may increase loss of nutrients from wetlands. Peat may be eroded leading to emissions of carbon dioxide.

Climate changes will lead to a more pronounced seasonality in flow patterns in rivers and seasons in lochs. Rivers may be adversely affected by low flows in summer.



Warmer periods in summer will lead to the drying out of wetlands. This drying will result in the release of carbon, adding to greenhouse gases in the atmosphere. There have been significant temperature increases in waters in parts of Scotland; for example, Loch Leven experienced 1.5°C increase in mean spring temperature between 1970 and 2000. Increased temperatures will affect cold-water adapted species, such as Arctic charr, salmon and trout, and favour non-native species.

Action needed

As the climate warms it is important to manage wetlands so that they are in a resilient condition, and able to support existing species as well as species displaced from further south.

Managing land to maintain the store of carbon in vegetation and soils is also important, particularly in Scotland. Here peatlands and other carbon-rich soils form a very significant carbon reservoir, equivalent to over 180 years of Scottish greenhouse gas emissions at current emission rates. Ways to reduce carbon loss and increase the store of carbon include:

- * maintaining bogs, wetlands and peatlands and avoiding new drainage
- * restoring previously drained peatlands
- * keeping disturbance and cultivation, especially on carbon-rich soils to a minimum
- * maintaining woodland cover and encouraging woodland regeneration

Restoring natural processes in freshwater systems will make them better able to cope with a changing climate. Natural flood management techniques such as the creation of wetlands or floodplains will help to reduce flood risk. Wetland habitats can play a major role in slowing run-off from catchments and absorbing overspill within flood plains. These approaches are likely to cost much less and be more sustainable than building and maintaining engineered solutions such as barriers and walls. However they may require significant changes in land use, transport infrastructure, and business and housing developments. In practice a mix of engineered and natural flood management approaches is more achievable. These measures should be integrated with improving riparian (waterside) habitats to reduce the impact of increasing river water temperature on salmon and trout in particular.



Weblinks

Education Scotland - Secondary resource on climate change
<http://www.educationscotland.gov.uk/exploringclimatechange/>

Education Scotland – Early years and primary resource on climate change
<http://www.educationscotland.gov.uk/weatherandclimatechange/index.asp>

Scottish Environment Protection Agency Information on climate change, flooding and fresh waters in Scotland - http://www.sepa.org.uk/climate_change.aspx

Scottish Water - includes an education website
<http://www.scottishwater.co.uk/education/>

River runners – SNH Naturally Scottish series of booklets
<http://www.snh.gov.uk/publications-data-and-research/publications/search-the-catalogue/publication-detail/?id=31>

Boglands – SNH Scotlands Living Landscapes series publication.
<http://www.snh.gov.uk/publications-data-and-research/publications/search-the-catalogue/publication-detail/?id=856>

‘Storing up trouble’ – *SNH, The Nature of Scotland*. Spring 2009. - article on importance of peatlands & woodlands in storing carbon - <http://www.snh.gov.uk/publications-data-and-research/publications/search-the-catalogue/publication-detail/?id=1363>

SNH has also has a wide range of data and information on Scotland’s nature and landscapes - <http://www.snh.gov.uk/publications-data-and-research/environmental-data/>

For ideas of places to visit – Education Scotland’s Outdoor Learning pages,
<http://www.educationscotland.gov.uk/learningandteaching/approaches/outdoorlearning/index.asp> - have a section on ‘Where to go’
<http://www.educationscotland.gov.uk/learningandteaching/approaches/outdoorlearning/placestolearnoutdoors/wheretogomap/index.asp>

Curriculum Links

Curriculum for Excellence Experiences and Outcomes Science: Pupils can discuss the possible impact of atmospheric change on the survival of living things.

Science: Pupils can report and comment on current scientific news items to develop their knowledge and understanding of topical science. Having selected scientific themes of topical interest, pupils can critically analyse the issues, and use relevant information to develop an informed argument. Pollution – greenhouse effect and impacts; Energy and its Uses – greenhouse effect

Social Studies: People, place and environment – Pupils can explore and appreciate the wonder of nature and have played a part in caring for the environment. Pupils can discuss the environmental impact of human activity and suggest ways in which we can live in a more environmentally-responsible way.

Biology: Adaptation to change – survival; Pollution – sources and effects of air pollution; Environmental Biology – Effects of increased energy production;

Chemistry: Fuels – pollution problems associated with burning oil and gas

Geography: The Physical Environment; Physical Environments – Atmosphere; Geographical Issues Unit

Environmental Science: Environmental issues: Effects of human activity on global environment; Effects of human activity on local environment; Natural Resources Use – Environmental effects of different energy sources; Ecosystems – effects of human activity on ecosystems; Natural Resources Use – Environmental impacts of energy sources; Investigating Ecosystems – impacts of human activities