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Mitigating climate change impacts on Scottish lochs

Linda May[1], Miriam Glendell[2], Kerr Adams[2], Zisis Gagkas[2], Lily Gouldsbrough[3], Iain Gunn[1], Megan Hannah[1], Michaela Roberts[2], Bryan Spears[1], Philip Taylor[1], Stephen Thackeray[3], Mads Troldborg[2], Erica Zaja[1]

[1]UK Centre for Ecology & Hydrology, Bush Estate, Penicuik, Midlothian EH26 0QB, UK
[2]The James Hutton Institute, Craigiebuckler, Aberdeen AB15 8QH, Scotland
[3]UK Centre for Ecology & Hydrology, Lancaster Environment Centre, Lancaster LA1 4AP, UK

The problem

Lochs are an important part of Scotland's natural heritage. They provide habitat for plants and wildlife, and recreational and health benefits to people. Lochs are an internationally famous feature of the Scottish landscape. Think of Loch Lomond, Loch Ness, amongst others. People have been interested in our lochs for many years, but understanding how they will respond to the pressures they face today has never been more important.

Global temperatures have increased by about 1.5°C since pre-industrial times, rapidly altering our planet's ecosystems. Climate change poses an imminent threat to the quality of Scottish lochs. Air and water temperatures are increasing, and rainfall patterns are changing. More intense rainfall flushes more pollutants from land to water.

Most Scottish lochs have warmed since 2015. As our climate changes, they will start experiencing even higher water temperatures, or heatwaves. High water temperatures combined with low flushing rates could push lochs beyond their limits of resilience; this would reduce their amenity value and endanger public health.

One of the most serious consequences of warmer waters and higher levels of runoff into lochs is the increased risk of algal blooms. Algal blooms are rapid accumulations of algae and cyanobacteria that make lochs look green and can be toxic to people and wildlife. Algal blooms can lead to habitat degradation, biodiversity loss and reduced amenity value. They also threaten water security.

There are three key elements that, together, allow algal blooms to form:

- warm temperatures
- strong sunlight, and
- nutrients, especially phosphorus.

Reducing any one of the key elements in this 'triangle' will reduce the risk of algal blooms.

Phosphorus is a main constituent of agricultural fertilisers. Any excess not taken up by crops travels from land to water under wet conditions. Under climate change, the UK will likely be warmer and wetter in winter, hotter and drier in summer, and experience more storms and droughts. These changes will increase the phosphorus concentrations of lochs and, consequently, the risk of algal blooms developing.

Solutions

While we cannot reduce temperatures and sunlight, we can change the amount of nutrients entering waterbodies, especially as runoff. But how?

We can reduce phosphorus inputs to water by installing buffer strips; these vegetated areas separate agricultural fields from water courses and intercept runoff. We can also reduce nutrient runoff by reducing fertiliser applications to agricultural land.

We can also control the nutrients that are already in lochs by:

- removing nutrient laden sediment, and
- adding chemicals to sink the algal blooms

But, these measures are expensive and often need to be repeated. They can also be dangerous, because sediment may contain heavy metals and broken down algal cells can release toxins into the water.

Some measures are more effective than others at preventing nutrients ending up in our freshwaters. Small scale interventions, such as more buffer strips, have much less impact in reducing phosphorus run off. However, reducing fertiliser application rates to at or below the agronomic optimum almost halves phosphorus runoff. Under a temperature increase of 1.5°C, if combined with sustainable land management, phosphorus losses from land to water could reduce by about 20% by 2080. This would break the algal bloom 'triangle', improving the quality of our freshwaters, restoring habitat for nature and ensuring safe, clean water for recreational use and water supply.

Implications and outcomes

What will happen if we don't reduce nutrient inputs to our lochs? If we intensify agricultural production, phosphorus losses from land to water could more than double by 2080. This could increase the annual average phosphorus concentrations of our lochs by 87%. Many would then be likely to exceed the upper limits for safe use set by the World Health Organisation, and many more would fail to meet regulatory targets for high water quality.

At the moment, algal blooms cost Scotland at least £16.5 million per year in terms of water treatment costs, impacts on house prices, reductions in visitor numbers, and loss of biodiversity. The real costs are higher, because this excludes medical and veterinary costs for people and animals affected by algal bloom toxins. Also, it is estimated that the cost of reducing phosphorus levels in runoff before it enters our lochs would be about £56.4 million per year.

While we can't stop climate change, we can introduce measures to protect our lochs from its adverse effects. Lifestyle choices, including how we control greenhouse gas emissions, will determine how climate change affects water quality. We need to work with farmers, landowners, environmental regulators, and policymakers to co-develop sustainable solutions that will ensure the resilience of our freshwaters into the future. Although within waterbody measures could be used to mitigate climate change impacts at a site specific scale, these are unlikely to be cost effective for widespread use. Combining a low emissions pathway with measures to reduce phosphorus runoff from agricultural land is the best way to prevent costly algal blooms and maintain the good quality of Scottish lochs.

We understand the problem and its solutions; we need to act now.

Please reference this project summary as follows: Linda May, Philip Taylor, Stephen Thackeray, Bryan Spears, Iain Gunn, Erica Zaja, Lily Gouldsbrough, Megan Hannah, Miriam Glendell, Zisis Gagkas, Mads Troldborg, Michaela Roberts, Kerr Adams. (2024) *Mitigating Climate Change Impacts on the Water Quality of Scottish Standing Waters project summary.* CRW2022_03. Scotland's Centre of Expertise for Waters (CREW).

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