

Natural sources of phenols and mitigation measures to reduce their release into the water environment

Research Summary



Photo: David Richards



Photo: Nikki Baxendale



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RESEARCH UNDERTAKEN

This study investigated the current state of knowledge reported in the literature on the sources of natural phenolic compounds; factors that trigger their release into the environment; their risks to water sources and potential mitigation measures to reduce these risks. A potential risk assessment methodology, which assesses the terrestrial sources of phenolic compounds and the potential risk to ground and surface waters was presented.

The risk assessment provides a set of decision rules that define the source and transport risks of natural phenolic compounds. It combines land management, the presence of organic soils with groundwater vulnerability and erosion risk for surface waters.

KEY FINDINGS

1. Natural sources of phenolic compounds include vegetation, trees, soil microorganisms, soil leachates, decomposition of dead animals and plants and residues from forest fires and muirburn.
2. Degradation of phenols in soil and water is influenced by environmental factors such as extreme pH (<3 and >9), temperature, UV exposure, oxygen levels and nutrient availability.
3. Peatlands contain high concentrations of phenolic compounds, which are recalcitrant. However, any disturbance of these soils that leads to increases in oxygen levels can result in the activation of polyphenol oxidase enzymes and an increased risk of the export of phenols to water courses.
4. The key factors in Scottish catchments that can enhance DOC and phenol release are drainage and erosion, particularly of peatlands, muirburn and recovery from acid deposition. Climate change is expected to accelerate these effects due to rising temperatures and the increase in high intensity rainfall events, prolonged wetting and drying cycles, the absence of snow cover, increase in freeze and thaw events and an increase in wildfires.
5. Organic compounds (dissolved and particulate) including phenolic compounds are released to surface water through soil erosion and runoff, and to groundwater via leaching.
6. Low molecular weight, soluble phenolic compounds pose a greater risk to water sources than the less soluble higher molecular weight phenolic compounds.
7. There is a positive correlation between dissolved organic carbon (DOC) and occurrence of phenolic compounds in water bodies.
8. Targetted monitoring of DOC concentrations could be a useful indicator for phenol levels in surface and groundwaters. Where elevated levels of DOC are detected, further investigation of phenolic compounds is proposed.
9. Potential mitigation measures identified include peatland restoration, which has been shown to reduce DOC release.

RECOMMENDATIONS

The main findings from this study are:

- Changes in observed DOC concentrations may be used as an indicator of potential changes in the presence of phenolic compounds in surface and groundwaters.
- Restoring peatlands is one of the key factors of locking carbon in the soil and reducing the release of DOC and phenolic compounds to water sources.
- There are very few studies on the presence of phenolic compounds in the environment released from natural sources and their subsequent transfer to watercourses. A recommendation from this work would be to carry out a long-term study of the types of DOC and phenolic compounds in Scottish drinking water catchments. This would provide up to date data to validate the risk assessment developed in this project, and also to better understand the potential drivers of the release of phenolic compounds and their transfer in Scottish drinking water catchments.

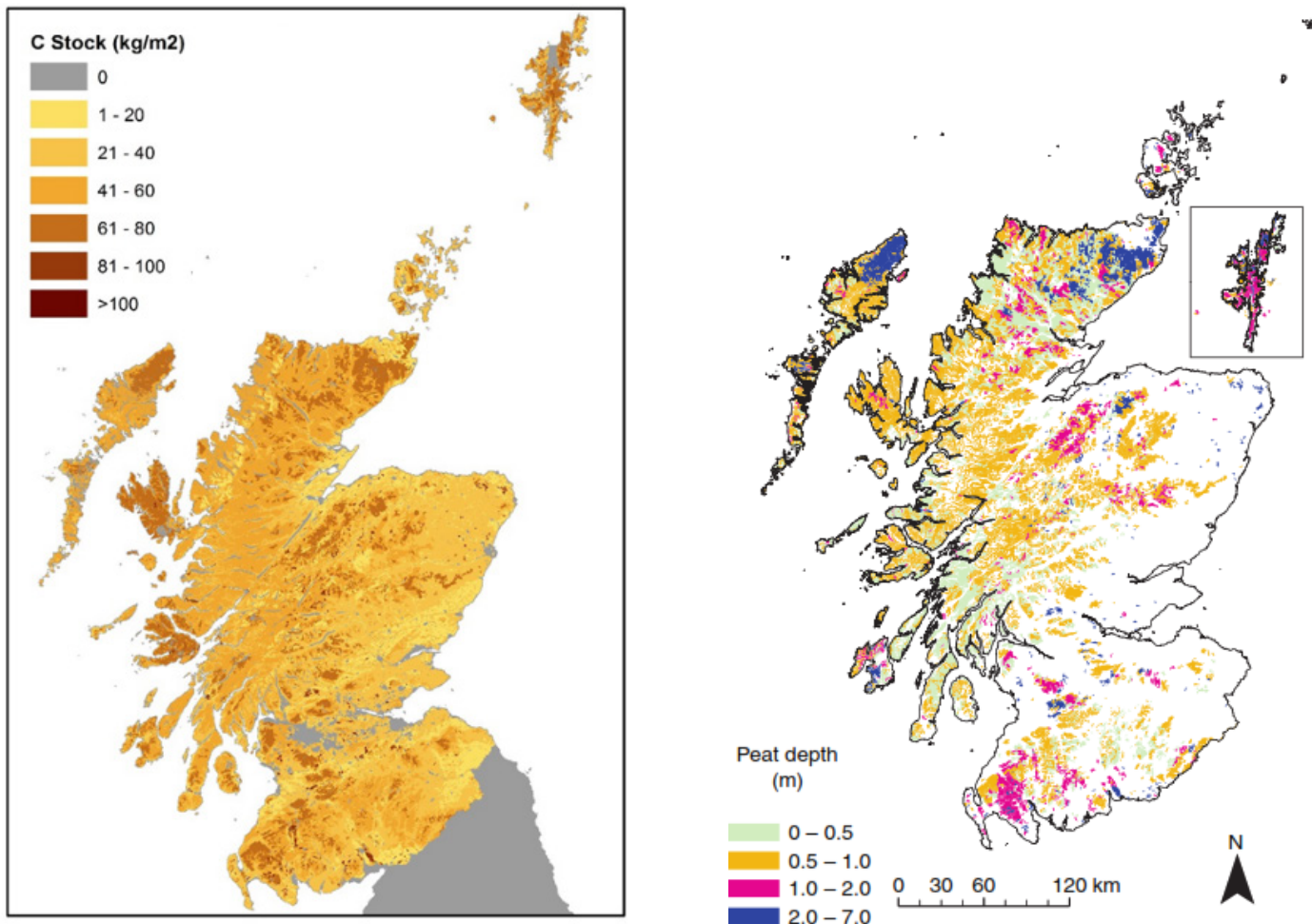


Figure 1: Carbon stock to 1 m depth (left), taken from Baggaley et al., (2016) and peat depth in Scotland (right) from Chapman et al. (2009)

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