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Assessing the source and delivery of organic carbon at a catchment scale using a combined sediment fingerprinting and carbon loss modelling approach

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Quantifying land use sources and understanding the dynamics of organic carbon (OC) in river catchments is essential to reduce both on-site and off-site impacts of soil OC erosion. The lake area of Loch Davan, located in Aberdeenshire, Scotland, has been significantly reduced over the last century due to sediment inputs and, in this study, we aimed to identify the primary source(s) and delivery of OC to the loch's main feeder stream, Logie Burn and its major tributaries.

The relative contribution of different land use sources to organic matter load in waterways can be assessed using sediment fingerprinting (SF) with plant-specific biomarkers such as *n*-alkanes. However, application of the land use sources based on SF in catchment management is hindered by the following issues: i) broad land use classifications cannot provide accurate OC origins if the same land use exists in multiple locations within a catchment; each with its own susceptibility to erosion and connectivity to the streams, and ii) eroded soil is not the only source of plant-specific biomarkers such as *n*-alkanes and direct input of leaves or litter to waterways could mask the input from eroded soils.

This inter-disciplinary study aimed to improve upon the SF method by firstly constructing a "Carbon Loss Model" (CLM) to estimate areas of a catchment most likely to provide OC to waterways. We then compared the land use sources of OC estimated using the CLM and SF to improve our insights into both the origin and fate of eroded OC. Secondly, we considered whether soil specific tracers (neutral lipids) of soil microbial or fungal origin, combined with plant specific *n*-alkanes, could help to reduce the error in SF when discriminating land cover classes, facilitating a more accurate estimation of OC origins by adding a more soil - rather than vegetation - specific fingerprint.

Results show that addition of short-chain neutral lipid fatty acid biomarkers to plant specific *n*-alkane tracers led to a significant decrease in error when distinguishing between arable, pasture, forest and moorland land uses (error reduction 1.8-9%). Comparison of the land use sources of OC estimated using the CLM and SF identified that areas of estimated high carbon loss were not always the regions contributing most sediment to the streams and that non-erosion processes

within the riparian corridor are likely contributing OC to the waterways. This research highlights that to better understand the origin of sediments and OC across the terrestrial-aquatic continuum we must understand both sides of that continuum (the susceptibility of terrestrial OC to erosion and delivery, and the characteristics of OC within the waterways) as well as the role(s) of the riparian area that links the two.

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