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Tracing the sources of organic carbon in freshwater systems

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Quantifying the lateral fluxes of carbon from land to inland waters is critical for the understanding of the global carbon cycle and climate change mitigation. However, the crucial role of rivers in receiving, transporting and processing the equivalent of terrestrial net primary production in their watersheds has only recently been recognised. In addition, the fluxes of carbon from land to ocean, and the impact of anthropogenic perturbation, are poorly quantified. Therefore, a mechanistic understanding of the processes involved in the loss and preservation of C along the terrestrial-aquatic continuum is required to predict the present and future contribution of aquatic C fluxes to the global C budget.

This pilot study examines the effect of land use on the fate of organic matter within two headwater catchments in Cornwall (UK) in order to develop a methodological framework for investigating C-cycling across the entire terrestrial-aquatic continuum. To this end, we aim to characterise the spatial heterogeneity of soil erosion driven lateral fluxes of SOC to identify areas of erosion and deposition using ^{137}Cs radio-isotope and trace the terrestrial versus aquatic origin of C along the river reaches and in lake sediments at the catchment outlet.
The 3D spatial distribution of SOC has been investigated by sampling three depth increments (i.e. 0-15cm, 15-30cm and 30-50cm) along 14 hillslope transects within two sub-catchments of $\sim$km^2 each. In total, 80 terrestrial sites were monitored and analysed for total C and N, and bulk stable ^{13}C/^{15}N isotope values, while ^{137}Cs was used to obtain a detailed understanding of the spatial – temporal variability in erosion driven lateral fluxes of SOC within the catchments. The relative contribution of terrestrial and aquatic C was examined along the river reaches as well as in lake sediments at the catchment outlet by considering n-alkane signatures.

By linking the C accumulation rates in lake sediments over decadal timescales from both terrestrial and aquatic sources as recorded in lake sediments to the measured rates of soil erosion and terrestrial & aquatic CO_2 respiration rates, this study has paved a way towards a novel and cross-disciplinary approach to investigate and further improve current status of knowledge as regards C-cycling across the entire terrestrial-aquatic continuum. ^{137}Cs was found to be useful to understand the dynamics and spatial pattern of lateral fluxes of sediment & C at the catchment scale, while tracing chemical composition of C using n-alkanes and stable isotopes (δ^{13}C, δ^{15}N) allowed distinguishing between the terrestrial vs. aquatic origin of C and determining main sources of particulate organic carbon in the aquatic environment within the two study catchments.