Land-use-based freshwater sediment source fingerprinting using hydrogen isotope compositions of long-chain fatty acids

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Rapidly changing land use patterns and frequent extreme weather events have resulted in an increased sediment flux to freshwater systems globally, highlighting the need for land-use-based sediment source fingerprinting. Application of variability in hydrogen isotope compositions (delta H-2 values) of vegetation-specific biomarkers from soils and sediments is relatively underexplored for land-use-based freshwater suspended sediment (SS) source fingerprinting, but has the potential to complement the information from routinely applied carbon isotope analysis and provide new insights. We analysed delta H-2 values of long-chain fatty acids (LCFAs) as vegetation-specific biomarkers in source soils and SS collected from the mixed land use Tarland catchment (74 km(2)) in NE Scotland, to identify stream SS sources and quantify their contributions to SS. Plant growth form was the primary control on source soils LCFAs (n-C26:0, n-C28:0, n-C30:0) delta H-2 variability, while the isotopic composition of source water had no significant control. Forest and heather moorland soils covered with dicotyledonous and gymnosperm species were differentiated from arable land and grasslands soils covered with monocotyledonous species. SS samples collected for fourteen months from the Tarland catchment with a nested sampling approach showed monocot-based land use (cereal crops, grassland) to be the major source of SS with 71 +/- 11% contribution on catchment-wide scale averaged throughout the sampling period. Storm events after a dry summer period and sustained high flow conditions in the streams during autumn and early winter suggested enhanced connectivity of more distant forest and heather moorland land uses covering relatively steep topography. This was shown by an increased contribution (44 +/- 8%) on catchment-wide scale from dicot and gymnosperm-based land uses during the corresponding period. Our study demonstrated successful application of vegetation-specificity in delta H-2 values of LCFAs for land-use-based freshwater SS source fingerprinting in a mesoscale catchment where delta H-2 values of LCFAs were primarily controlled by plant growth forms.

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