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Hydrology and seasonality determine distinct DOC export mechanisms in contrasting upland catchments in Scotland

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How climate variability influences soil processes, production and export of DOC are important in understanding hydrologically mediated carbon losses from soils and its affect on stream and river water quality. This necessitates understanding both biogeochemical and hydrological factors that control the quantity and timing of carbon availability for export from soils to the drainage network. Long-term records of DOC concentrations at upland catchments with contrasting climatic characteristics in Scotland were investigated for intra-annual relationships to evaluate potential long-term seasonal as well as inter-annual patterns.

Catchments in West-Central Scotland (>2000 mm/yr rainfall) with high rainfall-runoff ratios, short transit times and well-connected responsive soils show a distinct annual periodicity in DOC concentrations throughout the long-term datasets. Increased DOC concentrations occurred between June and November with correspondingly lower DOC concentrations from December to May. This appears unrelated to discharge, and is dependent mainly on higher temperatures driving biological activity, increasing decomposition of available organic matter for rapid export.

Relatively drier catchments (ca. 1000 mm/yr) have lower rainfall-runoff ratios, longer transit times and annual drying-wetting regimes linked to changing connectivity of soils. These are characterised by seasonal DOC concentration-discharge relationships with an autumnal flush of DOC. Temperature influences the availability of organic matter for eventual DOC transport producing a high DOC concentration-discharge relationship in summer/autumn and low DOC concentration-discharge relationship in winter/spring.

These two distinct modes of seasonal DOC transport have important implications for understanding changes in DOC concentrations and export brought about by climate changes (temperature, rainfall and deposition patterns) and modeling of aquatic carbon losses from soil-types under different hydrological regimes.