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The controls on fluvial carbon efflux during erosion events in peatlands

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Global peatlands store an unprecedented quantity of carbon but it is vulnerable to erosion into fluvial systems. Fluvial networks are being recognised as areas of carbon transformation, with particulate organic carbon processed to dissolved organic carbon, and CO_2. Here we examine this process in peatland streams, specifically in the context of upland sediment erosion and downstream organic matter fluvial transport.

Previous studies indicate biodegradation and photodegradation as key processes controlling the transformation of organic carbon in fluvial systems, with initial concentrations of dissolved organic carbon identified as a control on the rates of carbon mineralisation. This study manipulates temperature and incident light intensity to investigate carbon mineralisation rates in laboratory simulations of peatland sediment transport into fluvial systems. By directly measuring gaseous CO_2 emissions from sampled stream water the relationship between temperature and light intensity with carbon processing is identified. In simulations where sediment (as particulate organic matter, POM) is absent from the system, biodegradation is consistently the dominant process affecting mineralisation evidenced by the influence of water temperature in models predicting carbon mineralisation rates. This influence is independent of water sample DOC concentration. In simulations where POM is added, representing a peatland river receiving terrestrial sediment, water sample DOC concentration accounts for 79% of the variation seen in carbon mineralisation rates, whilst temperature and light intensity account for 11% and 3% respectively. When sediment is added to water with a low DOC concentration, temperature continues to be the dominant variable driving carbon mineralisation rates. However when using samples with a high DOC concentration, CO_2 production is more affected by changes in light intensity with mode ls of total CO_2 efflux more accurate if light intensity is log10 transformed.

This study presents novel data of directly measured CO_2 efflux from simulations of peatland sediment transport into fluvial systems, suggesting peatland erosion introduces further complexity to these dynamic systems where rates of carbon transformation processes and the influence of specific environmental variables are interdependent. Given anthropogenic climate change is thought to be a leading risk factor perpetuating peatland erosion, understanding the fate of sediment in rivers is likely to be of increasing importance to carbon budgeting and ecosystem function studies.