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Getting Terrestrial Carbon into the Aquatic Conduit: Riparian peat controls from daily to centennial time-scales

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Riparian zones (RZ) are important sources of biogenic carbon (both dissolved organic carbon (DOC) and dissolved inorganic carbon (DIC)) reaching surface waters. This is the so-called "aquatic conduit" that returns large quantities of terrestrial carbon to the atmosphere. But it is often just a narrow 'dominant source layer' (DSL) within the riparian profile that is responsible of most of the carbon production and water to surface waters. But how long can this fraction of the RZ sustain lateral DOC/DIC fluxes as the sole source of exported carbon? This study estimates this theoretical turnover time of carbon and water in the DSL by comparing carbon/water pools and lateral fluxes in the DSL of 13 riparian profiles in northern Sweden. The thickness of the DSL was 36 $\pm$ 18 ($\pm$SD) cm, i.e. only about one third of the 1 metre deep riparian profile. The 13 RZ exported 8.7 $\pm$ 6.5 g C m-2 year-1. The estimated C turnover times were of the order of hundreds to thousands of years, while water residence time varied from hours to weeks. Net ecosystem production in the RZ can maintain the C export, including inorganic C, without drawing down the riparian pools. This was supported by measurements of stream DO14C that indicate modern carbon as the predominant fraction exported.
Upscaling these results using representative data sets of stream DOC and CO_2 concentrations, an empirically derived gas transfer model and the characteristics of a virtual stream network of Sweden enables us to present national CO_2 emission and DOC export estimates for all Swedish headwater streams. These results further underline the importance of the riparian zone for terrestrial carbon export in the boreal/hemiboreal zone.