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# Scaling of Dissolved Organic Carbon Removal in River Networks

Enrico Bertuzzo (1), Ashley M. Helton (2), Robert O. Hall Jr. (3), and Tom J. Batin (4)

(1) Department of Environmental Sciences, Informatics and Statistics, University of Venice Ca' Foscari, 30170 Venice, Italy, (2) Department of Natural Resources and the Environment and the Center for Environmental Sciences and Engineering, University of Connecticut, Storrs, CT 06269, USA, (3) Flathead Lake Biological Station, University of Montana, Polson, MT 59860, USA, (4) Stream Biofilm and Ecosystem Research Laboratory, Ecole Polytechinque Fédérale de Lausanne, Lausanne, CH-1015, Switzerland

Streams and rivers play a major role in the global carbon cycle as they collect, transform and deliver terrestrial organic carbon to the ocean. The rate of dissolved organic carbon (DOC) removal depends on hydrological factors (primarily water depth and residence time) that change predictably within the river network and local DOC concentration and composition is the result of transformation and removal processes in the whole upstream catchment. We thus combine theory of the form and scaling of river networks with a model of DOC removal from streamwater to investigate how the structure of river networks and the related hydrological drivers control DOC dynamics. We find that minimization of energy dissipation, the physical process that shapes the topological and metric properties of river networks, leads to structures that are more efficient in terms of total DOC removal per unit of streambed area. River network structure also induces a scaling of the DOC mass flux with the contributing area that does not depend on the particular network used for the simulation and is robust to spatial heterogeneity of model parameters. Such scaling enables the derivation of removal patterns across a river network in terms of clearly identified biological, hydrological and geomorphological factors. In particular, we derive how the fraction of terrestrial DOC load removed by the river network scales with the catchment area and with the area of a region drained by multiple river networks. Such results further our understanding of the impact of streams and rivers on carbon cycling at large scales.