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Enhanced bioavailability of dissolved organic matter (DOM) in human-disturbed streams in Alpine fluvial networks

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Abstract:
The influence of human activities on the role of inland waters in the global carbon (C) cycle is poorly constrained. In this study, we investigated the impact of human land use on the sources and biodegradation of dissolved organic matter (DOM) and its potential impact on bacterial respiration in 10 independent catchments of the Lake Geneva basin. Sites were selected along a gradient of human disturbance (agriculture and urbanization) and were visited twice during the winter high-flow period. Bacterial respiration and DOM bioavailability were measured in the laboratory through standardized dark bioassays, and the influence of human land uses on DOM sources, composition and reactivity was assessed from fluorescence spectroscopy. Bacterial respiration was higher in agro-urban streams but was related to a short-term bioreactive pool (0–6 d of incubation) of autochthonous origin, whose relative contribution to the total DOM pool increased with the degree of human disturbance. On the other hand, the degradation of a long-term (6–28 d) bioreactive pool related to terrestrial DOM was independent from the catchment land use and did not contribute substantially to aquatic bacterial respiration. From a greenhouse gas emission perspective, our results suggest that human activities may have a limited impact on the net C exchanges between inland waters and the atmosphere, as most CO_2 fixed by aquatic producers in agro-urban streams is cycled back to the atmosphere after biomineralization. Although seasonal and longitudinal changes in DOM sources must be considered, the implications of our results likely apply more widely as a greater proportion of autochthonous-DOM signature is a common feature in human-impacted catchments. Yet, on a global scale, the influence of human activities remains to be determined given the large diversity of effects of agriculture and urbanization on freshwater DOM depending on the local environmental context.

Keywords: biodegradation, dissolved organic matter, bacterial respiration, human disturbance, autochthonous, carbon cycle