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Soil organic carbon decomposition rates in river systems: effect of experimental conditions

Man Zhao, Liesbet Jacobs, Steven Bouillon, and Gerard Govers
KU Leuven, Earth and Environmental Sciences, Belgium

Rivers receive large amounts of terrestrial soil organic carbon (SOC) and transport them from land to the ocean. Mounting evidence indicates that a large fraction of the eroded SOC, which is often very old, is quickly decomposed upon entering the river and never reaches the ocean. The mechanisms explaining this rapid decomposition of previously stable SOC remain unclear. In this study, we investigated the relative importance of two mechanisms possibly explaining this rapid SOC decomposition: (i) in the river water SOC is exposed to a different microbial community which is able to metabolise SOC much more quickly than the soil microbial community and (ii) SOC decomposition in rivers is facilitated due to the hydrodynamic disturbance of sediment. We performed different series of short-term (168h) incubations quantifying the rates of SOC decomposition in an aquatic system under controlled conditions. Organic carbon decomposition was measured continuously through monitoring dissolved O_2 concentration using a fiber-optic meter (FirestingO_2, PyroScience). In the control treatment, bottles of 320 ml of river water sampled from Dijle river (Leuven, Belgium) were used, without headspace, under dark conditions in a temperature-controlled room (20□). In a second treatment, soil material was added to river water filtered at 0.2 um to remove aquatic micro-organisms (MO) (SOC-MO treatment). The effect of the presence of an aquatic microbial community on SOC decomposition was simulated by adding an inoculum of unfiltered river water to a bottle containing the same soil material (SOC+MO treatment). Secondly, we investigated the effect of water motion on respiration rates by simulating the hydrodynamic disturbance of soil particles using a swing system to keep particles suspended in the water. All treatments described above were conducted under both standing- and shaking conditions. Each experiment was repeated six times and two types of soil were tested: one from arable land (sandy loam, 2.4%OC), and the other from a temperate forest site (sandy loam, 5.0%OC). Our result show that SOC indeed further mineralized in a riverine environment. Under both shaking and standing conditions, we found a significant difference between SOC-MO and SOC+MO treatments (paired t-tests, $p<0.05$), indicating that the presence of an aquatic microbial community enhanced the SOC decomposition process by 94%-131% depending on the soil type and shaking/standing conditions. In contrast, the effect of hydrodynamic disturbance was much less evident. When comparing SOC+MO at shaking vs. standing conditions for soil from arable land, SOC decomposition was increased by 13% at shaking condition ($p<0.05$) while no significant effect was found for forest soil ($p>0.05$). While some recent studies suggested that aquatic respiration rates may have been substantially underestimated by performing measurement under stationary conditions, our results indicate that this effect is relatively minor, at least under the

temperature conditions and for the suspended matter concentration range (500 mg/L arable land soil; 200 mg/L forest soil) used in our experiments.