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Contribution of different land-cover types to CO_2 emissions from streams and rivers, in South-Western Germany

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Recent findings indicate that freshwater ecosystems are significant sources of atmospheric greenhouse gases. While most quantitative estimates of CO_2 emissions were obtained for lakes, reservoirs, and rivers, only few studies considered smaller streams and headwater systems. Here, we present estimates of the CO_2 emissions from the 16 * 10^6 km long stream network in South-Western Germany (22272 km^2) including streams of Strahler order 1-7. We calculated equilibrium dissolved inorganic carbon speciation and partial pressure of dissolved $CO_2$from governmental water quality monitoring data (pH, temperature and alkalinity) available for 37 years. CO_2 partial pressure estimated for 1780 sampled stream segments were linearly extrapolated along the entire stream network consisting of 7890 segments. The mean partial pressure of dissolved CO_2 was 2286 ppm with a high spatial variation (SD 2735 ppm).

Moreover, the gas exchange velocity for each stream segment was estimated using flow velocity and slope. Our calculations based on dissolved CO_2 concentration, gas exchange velocity and water surface area yield a total emission rate of 86 Gg C per year with mean 1240 mg C m^{-2} d^{-1}arealflux. Stream segments with a Strahler order between 1 and 4 contributed to 48% of the total emissions, highlighting the importance of smaller streams and headwater systems for regional-scale carbon fluxes.

Finally, we investigated the contribution of land-cover types to CO_2 emissions. Our study area was divided into 6 different land-cover types, forested, cultivated, grassland, urbanized, vineyard and tree nursery. Areal normalized emissions of urbanized, vineyard, tree nursery, grassland, forested and cultivated were 17, 16, 12, 9, 8, 7 mg C m^{-2} d^{-1}, respectively.

The results of our study show clearly, that small streams play a non-negligible role in the carbon emissions from freshwaters. In addition, land cover further impacts the carbon emissions, e.g. urbanized areas showed the highest flux rates.