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Greenhouse gases fluxes from floodplain channels are governed by their hydrological connectivity: the case of the Rhône River

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Résumé

In the face of climate change, quantifying the contribution of natural and anthropogenic environments to the global carbon cycle is a critical issue. Recent studies have highlighted the role of inland waters as potential large sources of greenhouse gases emissions (GHGs), although many uncertainties remain as to their quantification and determinants. To date, the contribution of river systems has been poorly studied, with potentially very different fluxes according to the diversity of alluvial floodplain ecosystems (e.g. channels, side-arms) and hydrological variations. In response to these knowledge gaps, we conducted an extensive sampling of CO₂ and CH₄ surface water concentrations over one year in 13 floodplain channels of the Rhône River, covering a gradient of hydrological connectivity to the main channel. We aimed to quantify the dynamics of GHGs from the floodplain channels and to identify the effects of seasonal and hydrological variations. At each site, gas, water, and sediment parameters (e.g., organic carbon and nutrient concentration, grain size, pH) along with primary production values were measured at 6 times over the year. In addition, hourly values of oxygen concentration, conductivity, temperature and water level were recorded and crossed with river water flow to define hydrological connectivity variation. Our results show the structuring role of hydrological connectivity on the GHGs dynamics, with CO₂ and CH₄ emissions tending to increase as a function of floodplain channel disconnection, with some disconnected arms recording extremely high concentrations in CH₄, up to 64 μ M. High trophic status (C:N, primary production, total phosphorus, anoxia frequency), combined with low hydraulic constraints and high spring and summer temperatures seems to play a predominant role on the GHGs dynamics. Finally, this study provides the first empirical data on the GHGs dynamics from floodplains channels of large rivers, demonstrating the large contribution of these ecosystems to the global carbon budget, while illustrating the complexity of their spatio-temporal dynamics.

Mots-Clés: greenhouse gases, river, floodplain channels, biogeochemistry, ecosystem processes, Rhône

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