Reservoirs change downstream water quality and pCO2: a case study in reservoirs of the Seine Basin (France)

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The impact of reservoirs on downstream water quality has received widespread attention, but most current studies are based on short-term data only, and less attention has been paid to the impact of reservoirs on downstream carbon dioxide (CO2) concentrations. In present study, we assessed the nutrient (DIN: dissolved inorganic nitrogen, PO43-: orthophosphate, DSi: dissolved silica) budgets of the reservoirs (Marne, Aube, Seine, and Pannecière reservoirs) in the Seine Basin using long-term dataset (1998-2018), and we also evaluated the reservoir effect on downstream partial pressure of carbon dioxide (pCO2) based on field measurements during 2019-2020. Results indicated that the four reservoirs play important roles in nutrient retentions, the mean annual retention rates accounted for 16%-53%, 26%-48%, and 22%-40%of the inputs of DIN, PO43-, and DSi in the four reservoirs during the period 1998 to 2018, respectively. We further identified that three reservoirs (Marne, Aube, and Seine reservoirs) significantly changed downstream water quality during the emptying period, including increased the concentration of dissolved organic carbon (DOC) and biodegradable DOC, while lowered the concentrations of DIN, DSi, PO43-, and total alkalinity. Interestingly, we found that three reservoirs effectively decreased downstream pCO2, and enhanced the gas transfer coefficient of CO2 in downstream rivers by 1.3 times during the emptying period, which highlights the necessity to consider the potential impact of reservoirs on downstream riverine CO2 emissions. Finally, the findings of this study highlight the importance of the combination of biogeochemical and hydrological characteristics to understand the biogeochemical functioning of reservoirs to downstream rivers.