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Reservoir changes nutrient concentrations of their downstream rivers: Evidence from four reservoirs in the Seine Basin (France)

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Reservoir construction has changed the flows of water and nutrients along the river networks, locally increasing water residence time and inducing high nutrient retention with impact on downstream aquatic ecosystems. In the upstream drainage of the Seine basin, three reservoirs have been built in diversion (Der on the Marne River, Amance-Temple on the Aube R., Orient on the Seine R.). These hydraulic works have similar water management strategies in order to prevent downstream flooding in winter and early spring and support low river water flows in summer. Another reservoir (Pannecière) was built on the Yonne river streach. Herein, the long-term (1998-2018) budgets of nutrients and suspended matter (SM) were evaluated according to mass balance calculation with the available hydrological and water quality data in the four reservoirs (EPTB Seine Grands Lacs). Results suggested that the four reservoirs act as important sinks, with mean annual retention rates amounting 16% to 53% for DIN (NO_3^--N + NH_4^+-N + NO_2^--N), 26% to 48% for PO_4^{3-}-P, 22% to 40% for Si, and 36% to 76% for SM. Further analysis suggested that the annual residence time and the percentage of water released from reservoirs during the filling period (from December to June) significantly correlated with annual DIN retention rates in the four reservoirs ($p < 0.01$), which highlights the importance of reservoir water management strategies and impacts on DIN concentrations in their respective downstream rivers. Indeed, our field measurements in the three diverted reservoirs (Marne, Aube, and Seine Reservoirs), confirmed that the reservoirs significantly modified water quality in downstream rivers during the emptying period, i.e., lowered the concentrations of DIN, PO_4^{3-}-P, and DSi, while increased DOC and BDOC concentrations, and thereby modifying the biogeochemical functioning at least in the surrounding downstream rivers. Our results highlight future efforts for clarifying the impact of reservoir on biogeochemical processes farther downstream.