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Cascade dams influence on sediment characteristics and phosphorus distribution.

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Massive river artificialisation by dam construction, responding to the steadily increasing human demand of water and electricity leads to several environmental consequences, including alteration of hydrological dynamic and sediment discontinuity. Important decreases of water flows and sediment transport downstream impact phosphorus (P) flux to the ocean and its cycle, due to P sediment storage in dam reservoir. Moreover, the release of P from sediments may enhance eutrophication processes in dam reservoir.
Our study focused on the influence of cascade dams on physical and chemical characteristics of sediments and particularly on P sedimentary speciation along river continuum. Considering these results, the potential of P release from dam reservoir sediments was appraised and compared to un-impacted river parts. In addition, key parameters controlling P release at sediment/water interface were evaluated.
Champsanglard, Chézelles and Age are three consecutive hydroelectric reservoirs on Creuse River (France; respective surfaces area of 55 ha, 23 ha, 38 ha and approximative height of 20 m each) subjected to seasonal cyanobacterial blooms. Surface sediments (17 samples) were collected in dams and free-flow river sections (on a stretch of 17 km); chemical composition (Fe, Al, Ca, Mn and P), organic matter (OM) content, particle size distribution and P fractionation were analysed.
An abrupt change in sediment granulometry from a coarse-medium sand to silt texture going through free-flow river to dam reservoirs was observed. The same assessment was made in regard to OM content (from 3 $\pm$ 3% in river parts to 18 $\pm$ 3% in dams) and total P (0.27 $\pm$ 0.11 mgP/g DW in river parts to 1.8 $\pm$ 0.3 mgP/gDW in dams). P enrichment in sediment from dam reservoir is due to the retention of fine size particles. Relation between total P content and sediment grain size within each dam reservoir highlighted the role of slowdown river flow occurring in dams. In Champsanglard reservoir, sedimentary P fractionation reveals that 66% of P is supported by amorphous Fe and Mn oxy-hydroxides, reflecting the risk of P release under reducing conditions. In this dam reservoir, P content associated to this fraction increases from upstream to downstream, supporting the longitudinal variations of total P in this reservoir.
Furthermore, maximum sorption P sediment capacities and EPC0 (Equilibirum P Concentration) were determined in dam reservoirs and in free-flow river. These results enable to evaluate the concentration of P in the water column for which sediments might act as a source.

Keywords: Cascade hydropower dams, sediment, P fractionation, longitudinal variation, sorption P capacity.