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Understanding the effect of reservoirs on suspended sediments and biogeochemical fluxes over seasonal and storm scales

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Reservoirs such as dams modify the transport, the retention and the remobilization of sediments and nutrients in rivers. Such modifications can lead to strong degradation of downstream ecosystems as consequence of disturbances of biogeochemical cycles or habitat. When such negative impacts or cost of upgrading safety systems outweigh the benefits of dams, removal operation may be considered, e.g. Service (2011) inventoried more than 500 removals in USA in 10 years. The modification on River fluxes induced by the presence of a reservoir as well as the changes likely to occur in the case of its removal will depend on the fluxes from the catchment, on the functioning of the reservoir itself, and on the linkage between both systems. Therefore, we argue that characterizing the modification of hydrological, sediment and dissolved fluxes induced by dams should be achieved (i) on a variety of time scales (storms, seasons, years), and (ii) within an integrative approach that combine sediments, associated elements, and biological variables to enable understanding the biogeochemical processes impacted by the reservoir.

We conducted such an approach on the Sélune River, a 91 km river long, flowing to the Mont Saint-Michel Bay (France), draining a catchment of 1 083 km^2, and regulated by two hydroelectric dams:, La-Roche-qui-Boit and Vézin (16 and 36 m respectively). A set of station has been equipped to monitor water, sediment and dissolved elements fluxes from upstream to downstream the 2 dams since 2015. Sensors recorded every hour or less stream flow and physical and chemical parameters such as turbidity, temperature and conductivity on 4 stations. Water samples were collected every week and at higher frequency during storms on 2 stations to determine anions, dissolved nitrogen and silica, dissolved and total phosphorus concentrations and Carbone and nitrogen content of suspended solids. Results over 2 contrasted water years and more than 30 sampled storm events, showed that the two dams have 2 main effects:

(i) They act as buffer regarding suspended sediment and phosphorus annual and storm fluxes by trapping suspended solids. They also buffer concentration variations during storm events by mixing all dissolved elements with the water they store.

(ii) They act as biogeochemical reactors seasonally: in summer when light and temperature conditions are enhancing phytoplankton production into the reservoirs, the dissolved phosphorus and silica nutrients are consumed in the reservoirs whereas lower C/N content of downstream suspended material suggest exportation of autochthonous products from the reservoir.

No effect on stream flow dynamics is observed due to specific regulation strategy. Annual nitrate loads upstream and downstream to the dams do not show significant difference.

Service, R.F. (2011) Will Busting Dams Boost Salmon? Science 334, 888–892.