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How Damming is Modifying Riverine Nutrient Fluxes

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The damming of rivers represents one of the major anthropogenic disturbances of the natural cycles of water and nutrient elements on the continents. The associated changes in both the absolute and relative riverine fluxes of nutrients have far-reaching ecological implications, from individual ecosystems to the global biosphere. While dam reservoirs usually act as sinks of macronutrients along the river continuum, their effects on riverine fluxes and chemical speciation differ markedly from one nutrient element to another. Dams thus fundamentally alter nutrient stoichiometry and limitation, trophic conditions, and water quality in river ecosystems and receiving water bodies, including large lakes and coastal marine environments (Van Cappellen and Maavara 2015).

In this study, we review past and near-future trends in dam construction, and discuss the corresponding effects on the retention of nitrogen (N), phosphorus (P) and silicon (Si). Results from recent studies on the cycling dynamics of N, P and Si in Lake Diefenbaker, a 400 km^2 reservoir on the South Saskatchewan River, illustrate the decoupling of riverine nutrient fluxes caused by the presence of dams (Maavara et al. 2015). This decoupling is also apparent at the regional scale when comparing the retention of N and P by reservoirs for the entire Lake Winnipeg watershed (Donald et al. 2015). In order to assess the global scale effects of dams on riverine nutrient fluxes, we use a knowledge-based upscaling approach (Van Cappellen 2015; Maavara et al. 2014) that combines available data on elemental budgets for individual reservoirs, mechanistic models of nutrient cycling in surface water bodies, and the stochastic analysis of the model outcomes. The approach is applied to estimate the temporal and spatial changes in P retention by dams during the 1970-2030 period. Particular attention is given to the potential future reduction of P loading to rivers associated with the recent surge in dam construction, especially concentrated in South America, central Asia, Africa and Southeast Asia.

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