Damming drives global shift from heterotrophy to autotrophy in river systems

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Rivers act as a reactive conduit within the global carbon (C) cycle. Allochthonous organic C (OC) from terrestrial soils and biomass is transported downstream, autochthonous OC is produced by in-stream photosynthesis, and part of the OC is lost in transit due to mineralization and burial. Dam construction is possibly one of the most significant anthropogenic perturbations of the land-ocean C transfer. In this study we developed the first spatially explicit global estimate of OC burial, photosynthesis and mineralization in dam reservoirs for the years 1970, 2000, 2030 and 2050. We followed a mechanistic modeling approach which overcomes the limitations of relying on data-limited empirical models. Our model includes major in-reservoir fluxes, transformations and OC pools, and distinguishes between allochthonous and autochthonous OC burial and mineralization. The model is fully coupled to an existing reservoir phosphorus model to quantify nutrient-dependent changes in primary productivity (PP) [1]. Our results show that global mineralization fluxes in reservoirs exceed burial fluxes, and that this excess is higher during periods of intense dam construction, primarily due to decomposition of flooded terrestrial soils. We also show that increasing global reservoir PP fluxes from anthropogenic nutrient loading and trapping are leading to a shift from predominantly heterotrophic (respiration or mineralization dominant) to autotrophic (photosynthesis dominant) river systems. Regionally, Asia and South American are currently experiencing the greatest increases in all fluxes due to intense damming. Approximately one quarter of the global OC burial in reservoirs will take place in the Ganges basin by 2030, while the Amazon may acount for up to a third of the total reservoir mineralization.

[1] Maavara, T. et al. (2015). Global phosphorus retention by river damming. *PNAS* **112** (51): 15603-15608.