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# Impacts of large dam reservoirs on phosphorus and nitrogen concentrations and loads in Lake Winnipeg's watershed (Canada-USA)

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Since the 1990s, eutrophication symptoms including algal blooms and water quality deterioration, have persisted in Lake Winnipeg, with excess loads of the nutrient elements phosphorus (P) and nitrogen (N) considered the main driver. Previous researchers have highlighted the potential of dam reservoirs to reduce the loads of P and N along the river continuum. In this study, we analyzed the impact of reservoirs on the magnitudes and timing of P and N loads in the nearly 1,000,000 $km^2$ Lake Winnipeg watershed. Our analysis considered twelve large reservoirs for which P and N concentration plus discharge data were available for water flowing both in and out of the reservoirs. To generate continuous concentration and load time-series upstream and downstream of the reservoirs, we used the Weighted Regressions on Time, Discharge, and Season (WRTDS) model [1]. The results showed consistent patterns of load reduction, on average 51% for total P and 8% for total N. We further focused on variations in the B2 coefficient, which relates concentration (C) to discharge (Q) in the WRTDS model. We found a general decrease in B2 values between the reservoirs' inflow and outflow. That is, the reservoirs reduced the slope of the C-Q relationships. This was consistent with the observed decreases in the coefficients of variability of the concentrations of P and N between inflow and outflow. Thus, overall, the reservoirs tend to homogenize and decrease the concentrations of P and N and dampen the seasonal flushing of the nutrients towards Lake Winnipeg. While our results confirm the reduction of P and N river loads by dam reservoirs, especially for P, they also illustrate the high spatial and temporal variability of the load reduction effects. This presents a challenge when scaling up the impacts to more than 150 large (>10ha) reservoirs in the watershed and assessing the implications for nutrient enrichment and P and N limitation in Lake Winnipeg.

1. Hirsch, Moyer & Archfield (2010), *Am. Water Resour. Assoc.* 46, 857-880.