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Regional-scale nutrient levels in groundwaters around the Laurentian Great Lakes

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Watersheds around the Laurentian Great Lakes of North America (the U.S. part being under NOAA administration) see important contributions to their discharge from groundwater. As many of the river basins have widespread water quality problems, including eutrophication and harmful algal blooms in the lakes themselves, it is imperative to take groundwater contributions of nutrients into account. As the delay between input and output can attain decades, unrealistic management goals might be formulated if groundwater is not properly taken into account. Surface water discharge as well as nutrient fluxes have been extensively modeled at the regional scale in the past. However, many near-shore areas remain without gages, and only water budget approaches or spatially restricted hydrogeological models have been undertaken to estimate groundwater contributions. Here, we use (1) streamflow data from Canadian and U.S. databases (Water Office, HYDAT, USGS) combined with available information on baseflow index (the estimated proportion of baseflow in the total discharge) in order to estimate the amount of shallow groundwater flow / baseflow, (2) groundwater chemistry data from various databases for the early 2000s (Canada: OGS, PGMN; U.S.: Water Quality Portal, USGS, EPA). Preliminary statistical analyses of water quality data illuminated the need for extensive quality control and scrutiny. We combine these datasets to calculate baseflow nutrient fluxes as an estimate of the importance of nutrients in groundwater around the Great Lakes. We show that nitrogen compounds are important in many near-shore groundwater bodies under heavy population and agricultural pressure. Nitrogen fluxes in groundwater are of the same order of magnitude as surface water fluxes. Phosphorus levels are locally elevated in groundwater. In order to derive estimates of direct groundwater contributions to the lakes themselves, groundwater models need to be combined with estimates of nutrient transformations at the sediment / water interface.