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Applying a Bayesian Framework to Track Binational (Canada-USA) Loads and Sources

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The Red-Assiniboine River Basin (RARB) spans the Canada-USA border and discharges into Lake Winnipeg via the Red River. Recurrent harmful algal blooms caused by nutrient runoff coined Lake Winnipeg as “Canada’s sickest lake” and “most threatened in the World”. Invasive species such zebra mussels and spiny-water fleas have disrupted the aquatic ecosystem.

SPAtially Referenced Regression On Watershed Attributes (SPARROW) is a watershed model that follows a stream network and relates water quality conditions to nutrient sources, landscape delivery factors, nutrient transport, and losses in streams and reservoirs/lakes. We ported components of the first binational SPARROW model (deterministic calibrations) for RARB to a Bayesian framework to account for the main sources of uncertainty: errors resulting from loading estimates, parametric uncertainty (incorporated with prior distributions based on literature values), and model structural error. Open-source languages were used: Python, R, and WinBUGS. The limits of the computational capacity of WinBUGS were tested, with a total of over 70,000 catchments across the RARB.

We identified hot spots in Canada and USA at a sub-watershed scale, where wastewater treatment plants and agricultural inputs were the main contributors of Total Phosphorus (TP) to Lake Winnipeg. Within those hot spots, we looked at hot spots at the catchment scale, where wastewater treatment plants were contributing to nearly 100% of the TP loading.

We will present various scenarios testing hypotheses on different TP sources, such as the inclusion of urban areas, the subdivision of selected source variables, and the variation of wastewater treatment plant loadings.