Spatio-Temporal Vulnerability to Phosphorus Losses in Agricultural Watersheds

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Excess phosphorus loading increases the frequency of harmful algal blooms, posing severe threats to water quality. The re-emergence of harmful algal blooms in Lake Erie was a result of legacy phosphorus that had accumulated in soils and groundwater in agricultural watersheds due to historical phosphorus inputs, primarily from fertilizer used in excess of crop needs [1]. Consequentially, legacy phosphorus has the potential to be continuously exported from soils over several decades. A large-scale mass balance was conducted for Ontario watersheds to locate and quantify anthropogenic legacy phosphorus inputs from 1961 – 2016, utilizing existing datasets as well as historical reconstructions of phosphorus inputs. The mass balance model was implemented into a Geographical Information System (GIS) platform to delineate areas of legacy phosphorus accumulation and depletion within the landscape. These maps identified areas with high phosphorus inputs and potential stores of legacy phosphorus. The total cumulative legacy phosphorus surplus data were used to construct a vulnerability map by spatially comparing input locations to GIS layers of parameters that influence the fate and transport of phosphorus in soil. Soil data (e.g. clay content and soil texture) in conjunction with drainage data (e.g. topography, tile drain location, and proximity to surface water) were used in a multiple-criteria decision making model to identify areas that were vulnerable to leaching phosphorus. The final map indicates the relative vulnerability of soils leaching phosphorus to surface water across Ontario. The results inform nutrient management and abatement strategies as well as the implementation of conservation practices.

[1] International Joint Commission (2018)