Legacy Phosphorus across Canada: Insights from a 60-Year Dataset

Lamisa Malik, University of Waterloo; Danyka Byrnes, University of Waterloo; Meghan McLeod, University of Waterloo; Shuyu Chang, The Pennsylvania State University; Kimberly J. Van Meter, The Pennsylvania State University; Nandita B. Basu, University of Waterloo.

Human activities over decades of agriculture and urbanization have altered phosphorus (P) cycling, posing a threat to water quality and ecosystem function. Algal blooms have become a pervasive problem in both small and large waterbodies across Canada. Despite concerted efforts to reduce P loading to surface waters, there has yet to be a noticeable improvement in water quality. This can be attributed to the accumulation of legacy P in the landscape as a result of excessive use of synthetic fertilizers and the production of livestock manure. These legacy P can reach the waterbodies decades after implementing P management practices. Therefore, to better understand long-term P dynamics and their drivers, it is crucial to develop long-term datasets of P inputs and outputs.
We developed a 60-year (1961–2021), 250-meter grid resolution data of P components and P surplus across Canada. P surplus is the difference between P inputs (fertilizer inputs, livestock manure, detergent, and human waste) and non-hydrological P output (crop uptake). Our result shows the different drivers of P surplus across Canada. In Ontario and Quebec, the P surplus decreased from nutrient regulation programs in 1981 and subsequently rebounded in 2006 due to an increase in P fertilizer use. In prairie provinces, low P inputs and increasing crop yields have led to the mining of the P stores in the soils. This new, longer dataset will improve our understanding of long-term P dynamics and allow for explicit consideration of the impacts of legacy P on environmental outcomes.