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Sediment core reconstruction of changes in phosphorus loading and cycling accompanying a watershed's transition from agricultural to urban land use

STEPHANIE SLOWINSKI[1], JOVANA RADOSAVLJEVIC[1], ISABELLA IPPOLITO[1], ALYSSA GRAHAM[1], KATHRYN THOMAS[2], JOHAN WIKLUND[1], MAHYAR SHAFII[1], CHRIS T PARSONS[3], FEREIDOUN REZANEZHAD[1], ROLAND I HALL[1] AND PHILIPPE VAN CAPPELLEN[1]

[1]University of Waterloo
[2]Stillwater Environmental
[3]Environment and Climate Change Canada
Presenting Author: seslowin@uwaterloo.ca

Agricultural intensification and urbanization alter biogeochemical cycling and substantially increase the export of nutrients to downstream lake ecosystems. Here we reconstruct the post-1920 trajectories of external P loading and in-lake P recycling in Lake Wilcox (Ontario, Canada) based on analyses of a dated sediment core. Lake Wilcox is a kettle lake where the forested watershed was converted to agricultural use in the early 1900s, followed by rapid urban growth after the 1980s. The watershed's agricultural expansion was accompanied by a 2.5-times increase in the bulk sediment accumulation rate whereas urbanization caused a marked drop in the sediment accumulation rate to values below the baseline levels observed at the start of the agricultural period. This drop is attributed to the increase of impermeable land cover and, in more recent decades, the implementation of stormwater management ponds upstream of the lake. Although urbanization was accompanied by a significant up-core increase in the concentration of total P (TP) of the sediments, the TP burial rate decreased by around 60% from its peak value at the end of the agricultural period. The chlorophyll-*a* accumulation rate also peaked during the agricultural period and decreased as the watershed became more urbanized. Reconstructed TP budgets for the lake indicate that external TP loading decreased during the transition from agricultural to urban land use while the sediment TP recycling efficiency increased. These findings are consistent with our previous work on water chemistry trends in Lake Wilcox since 2000, which concludes that worsening symptoms of eutrophication, including enhanced in-lake P recycling and internal loading, are driven by salinization that strengthens the lake's water column stratification rather than by increased external P loads. These results highlight the large differences in the impact of agricultural versus urban land use on the lake's P budget and cycling, and on other aspects of the lake's biogeochemistry.