Salinization enhances eutrophication symptoms in a cold temperate urban lake

Jovana Radosavljevic1, Stephanie Slowinski1, Mahyar Shafii1, Fereidoun Rezanezhad1, Zahra Akbarzadeh1; William Withers2, & Philippe Van Cappellen1

1Ecohydrology Research Group, University of Waterloo, ON, Canada; 2City of Richmond Hill, ON, Canada
Contact: jradosav@uwaterloo.ca

Motivation & Objective

- Salinization → increasing problem for freshwater ecosystems in cold regions
- Negative effects of excess salt ions in freshwater lakes:
  - Impairs ecosystem health
  - Modifies water chemistry
  - Increases thermo-stratification → promotes anoxic conditions → impacts nutrient cycling

Objective: Assess the changes in water chemistry and eutrophic symptoms in Lake Wilcox (LW) during the period 1996–2018 and identify drivers of these changes using statistical analysis methods.

Study site & Dataset

- Location of Lake Wilcox in Ontario, Canada (left), and outline of its watershed (right).
- Rapid urbanization of the lake’s watershed since 1990s.
- Datasets (provided by City of Richmond Hill): Total phosphorus (TP), dissolved inorganic P (DIP), nitrate (NO3−), ammonium (NH4+), dissolved inorganic nitrogen (DIN), chloride (Cl−) and DO concentrations.
- Statistical analyses:
  - Principal Component Analysis (PCA) and Multiple Linear Regression (MLR) among variables of interest.
  - Chloride concentrations (as proxy for salinization) follows urbanization.

Results

- More intense periods of hypolimnion anoxia since 2005.
- External TP loadings and TP concentrations overall decreased; increased proportion of bioavailable DIP: increased internal loading.
- Rising salinity promotes water column stratification (quantified by the Brunt-Väisälä frequency (BVF)).

Statistical Analyses:

- Pearson’s correlation between the PCs and variables included in the analysis.
- Results of MLR with distinguished most important explanatory variables of PCs.

Conclusions

- Stratification and eutrophication symptoms are linked to urbanization via increased salinization rather than increased external P loading.
- Progressive salinization strengthens water column stratification and drives the accompanying changes in water chemistry → expansion of hypolimnion anoxia and enhancement of internal P loading → salinization contributes to maintaining eutrophic state.