URBAN PHOSPHORUS SPECIATION AND EXPORT LOADS: A PAIRED SEWERSHED FIELD AND MODELING STUDY

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Background

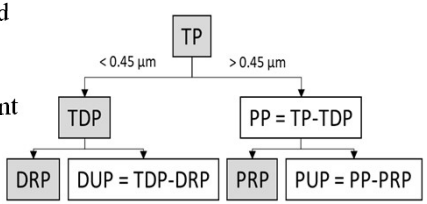
Urbanization impacts P species by:

- introducing additional sources of P, e.g., lawn fertilizers and pet wastes
- influencing P transport and water cycle through the alteration of the topography and land use/cover

Excess phosphorus (P) loading due to urbanization can enhance nuisance algal growth in the receiving waters and often results in *eutrophication* which is a significant environmental challenge.

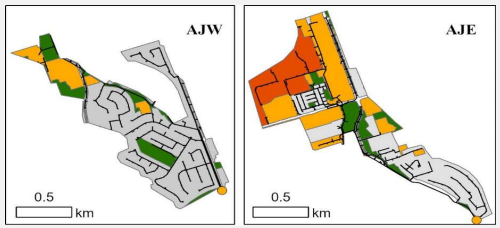
Objective

In this study, the objective was to estimate annual and seasonal loads of phosphorus (P) exported from two neighboring urban sewersheds (AJE and AJW) discharging into Lake Ontario. The following different chemical pools of P were considered: total P (TP), particulate P (PP), and dissolved P (DP), that in turn were divided in their respective reactive (R) and unreactive (U) fractions.

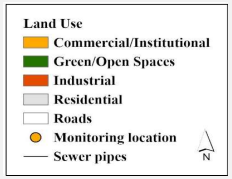


Method

Study area: The AJW sewershed is more residential while AJE is dominated by commercial and industrial land cover.



Ajax sewersheds



Sampling duration: Aug 2020-May 2022

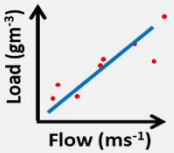
Modelling and calibration: A load-flow regression model coupled to the Stormwater Management Model (PCSWMM) was calibrated against measured flow and P speciation data and used to derive seasonal export concentrations (ECs) for the two sewersheds. The phosphorus model was calibrated for coefficients that are used in build-up and wash off functions. We used a typical regression model to correlate instantaneous loads (L), calculated as the product of concentration and flow, with flow (Q).

Seasonal EC** was estimated **per P species per sewershed

The $(a \pm \varepsilon\_a)$ component in the regression model found to be a proxy for potential of the sewershed to export phosphorus, hereafter denoted as Export Concentration (EC).

$$L_{i,j} = (a \pm \varepsilon_a)_{i,j} \times (Q_h)_j + (b \pm \varepsilon_b)_{i,j}$$

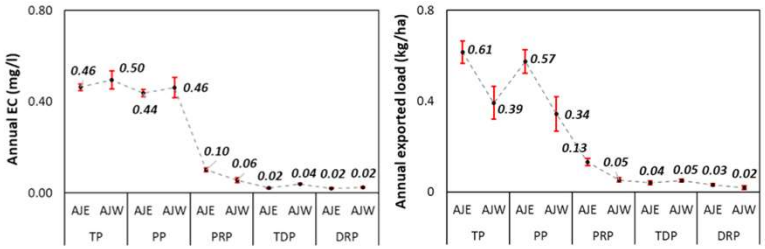
$$EC = (a \pm \varepsilon_a)_{i,j}$$



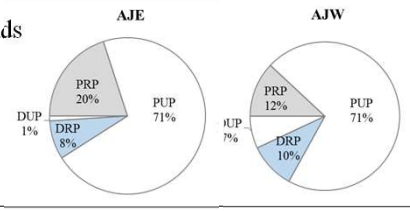
Data sampling: From August 2020 to May 2022, we monitored the concentrations of various operationally defined fractions of P in stormwater in addition to flow in the two storm sewers during high flow events caused by rain and snowmelt.

Results

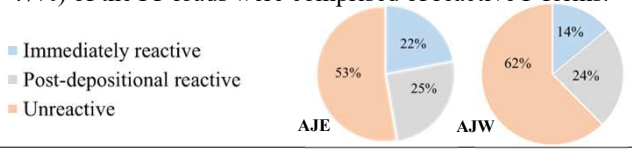
P loads and ECs: The annual P loads from the sewersheds were significantly different (AJE: 0.61±0.05 kg/ha/year; AJW: 0.39±0.07 kg/ha/year). Relative to AJE, the TP loads from the more vegetated AJW were enriched in both total DP (TDP) and reactive DP (DRP).



P fractions : the TP loads were dominated by PP (83-91% of TP), with slightly higher PP contributions for AJE.



Sediment sequential extraction (SEDEX) procedure results: Close to half (38-47%) of the PP loads were comprised of reactive P forms.



Conclusion

We suggested a novel and transferable approach to calibrate SWMM by introducing EC as a proxy of urban areas potential in exporting P species.

Also, seasonal, and annual load of different P species were estimated for two urban sewersheds. The large contribution of PP and further PRP to the TP loads indicates that DRP alone may not provide a reliable measure of the potentially bioavailable P exported from urban areas to downstream aquatic environments.

Acknowledgement

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