Quantitative insights into phosphorus loadings and speciation in urban catchments

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Phosphorus (P) loadings in stormwater runoff drained from urban landscapes causes eutrophication in aquatic ecosystems downstream of urban areas. Many recent research have addressed urban P dynamics to improve understanding about magnitudes and speciation of P in urban watersheds. We quantified P export and forms in four research sites including three urban sewersheds and a stormwater pond, all located within the drainage basin of Lake Ontario. P speciation laboratory analyses were conducted on water and sediment samples taken from our sites to measure a suite of P species, including total P (TP), total dissolved P (TDP), dissolved reactive P (DRP), dissolved unreactive P (DUP), particulate P (PP), and particulate reactive P (PRP). Using multiple linear regression (MLR) models, we quantified annual loadings of these P species, which appeared to be close to the lower limit of ranges reported in the literature. Average loadings among urban catchments were 0.54 kg ha-1 yr-1 for TP, 0.064 kg ha-1 yr-1 for TDP, 0.007 and 0.045 kg ha-1 yr-1 for DRP and DUP, 0.46 kg ha-1 yr-1 for PP, and 0.16 kg ha-1 yr-1 for PRP. Results indicated that larger catchment-scale loadings of reactive P species (DRP and PRP) were exported as residential development increased. We also found that the pond retained all P species significantly (77-94%), which, according to mass balance and sequential P extraction analyses, was attributed to both sedimentation and chemical precipitation of P with calcium mineral phases. Findings in our study imply that, due to loadings' variability imposed by land-use characteristics, urban P management options need to vary from a catchment to another. Furthermore, enhancing the formation of calcium phosphate and other redox-stable mineral phases could be explored as a best management practice in existing and new ponds for improving P retention.