Describing and understanding elevated solute concentrations and fluxes from urban watersheds using weekly data across 15 years

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Though >50% of humans live in urban areas and urban lands are rapidly growing, our understanding of the urban stream geochemistry is relatively poor in comparison to streams in forested or agricultural watersheds. Recent evidence suggests that urban streams, particularly in humid temperate climates, have elevated solute concentrations compared to forested and some agricultural streams. However, the trends in concentrations and sources of elevated solutes remain unclear.

We studied a gradient of four watersheds that range from forested to urban with 0% to 21% impervious surface cover (ISC) along with a fifth watershed that is agricultural. All watersheds were located within <20 km in the Piedmont province, Maryland, USA and underlain by felsic metamorphic bedrock. Land use categories were constant across the study period. The dataset was comprised of water samples collected weekly from each watershed from 1999 to 2014 (~3900) and measured for anion concentrations with a subset (~800) analyzed for cation chemistry. The Weighted Regression on Time, Discharge, and Season (WRTDS) model from the US Geological Survey, only previously applied to nutrients or chloride, was used to model trends in flow-normalized concentrations and fluxes, including statistical certainty of changes.

Cation and anion concentrations and fluxes become increasingly elevated with higher ISC, and most ions are elevated by more than an order of magnitude between the forested and most urban watersheds. Additionally, concentrations in the most urban watershed increased by as much as ~90 mg/L (4 mg/L/yr) over the study period. The elevated and increasing concentrations and fluxes, including increased calcium and bicarbonate, are primarily driven by non-point source contributions with road salt and concrete as the major sources.