Elevated solutes and weathering fluxes in urban streams due to non-point source contributions from concrete and road salt

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Emerging evidence suggests that solute concentrations are elevated in urban streams. However, previous work on solutes in urban watersheds has largely been focused on the ecological impacts or on nutrients. A Critical Zone and chemical weathering perspective offers a powerful approach for better understanding sources of elevated solutes and the implications for weathering fluxes from urban watersheds.

The effects of urban land use on stream chemistry were investigated in five small watersheds that lie along a forested to urban gradient in the tectonically quiescent Piedmont physiographic province in Maryland, USA. The watersheds are underlain by similar felsic metamorphic bedrock and contain no major point sources for solutes. The forested stream is dilute with Na^+ and HCO_3^- as dominant ions due to plagioclase weathering. In a watershed with 1% impervious surface cover (ISC), solute concentrations increase, and dominant ions are Na^+ and Cl^-, largely resulting from road salt inputs. In three watersheds with higher ISC (3.3, 17, and 25%), solute concentrations continue to increase as a function of ISC with no dominant cation and Cl^- as the dominant anion (though less so than for 1% ISC). The largest solute increases across the gradient are for Ca^{2+}, Cl^-, and Na^+, which rose by a factor of 64, 56, and 29, respectively; alkalinity increased by an order of magnitude. These increases occur despite rapid flow paths from impervious surfaces and presumably shorter water residence times in the more urban watersheds. While the forested watershed is significantly undersaturated with respect to carbonate, the most urban watershed approaches equilibrium with carbonate. Concrete weathering is the likely driver of increased alkalinity and much of the Ca^{2+} increase.

Based on preliminary calculations, chemical weathering fluxes from the forested watershed are 80% lower than the global average. Weathering fluxes from the most urban watershed are 13x higher than the forested watershed and 160% higher than the global average. Elevated Ca^{2+} and alkalinity fluxes from urban watersheds may somewhat offset CO_2–driven acidification in estuarine and coastal waters.