Monitoring the fate and transport of tire-derived pollutants in urban systems

Ashley B. Dann
Ph.D. Candidate
Department of Geological, Environmental, and Planetary Sciences
University of Maryland, College Park

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Abstract

Roadways greatly impact landscapes, as runoff from roads can carry salt ions, nutrients, metals, and organic matter into surrounding environments. Managing these pollutants individually can be challenging, and there may be opportunities to address shared pathways of sources, transport, and transformation through forest conservation, stream and wetland restoration, and dissolved organic matter (DOM) management. An emerging organic contaminant of concern from roadways is N-(1,3-dimethylbutyl)-N'-phenyl-p-phenylenediamine (6PPD), an antiozonant used in tire rubber to prevent degradation and prolong tire lifespan. When 6PPD reacts with ozone, it produces the toxic byproduct 6PPD-Q, which has been found to be highly toxic to salmon species. In this study, we investigate the biogeochemical drivers governing the fate and transport of 6PPD-Q and examine how DOM composition, along with other environmental controls such as pH and dissolved oxygen, may influence the attenuation of this emerging contaminant of concern. Using high-resolution spatial and temporal sampling, we monitored urban streams across Washington D.C., Maryland, and New York City to study the fate and transport of 6PPD-Q in relation to road density, impervious surface, restoration features, and sewer outfalls. Results showed 6PPD-Q had significant positive relationships with redox-sensitive elements (Fe, Mn), humic DOM fractions (C, M, A), and protein DOM fractions [(T, B), $p < 0.05$]. This study will inform strategies for managing 6PPD-Q through stream restoration, and potentially through DOM management.