Freshwater Salinization Syndrome: An Emerging Threat in Virginia’s Rivers?

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Reducing water quantity

The structure of this system is effective at reducing stormwater volume, thereby preventing streambed erosion and increasing groundwater recharge.

Improving water quality

With a reduced flow, stormwater is retained for a longer period, enabling pollutants, nutrients, and sediment to settle and be biologically transformed.

Mississippi-Ohio-Missouri (MOM) Basin Restoration

Better Fertilizer Management

Created/Restored Wetlands

Restored Riparian Bottomlands

2 million ha (5 million acres) of these ecosystems are needed
Billions of USD spent on Nutrient Management
Salinization – Why does it matter?

• Toxicity to aquatic life

• Invasive species and reduces biodiversity

• Corrosion/degradation of built infrastructure

• Ionic strength controls fate and transport of other chemicals

• Currently unmanaged for drinking water quality

• Watershed Retention Effects
Salinization – Why does it matter?

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North America's Waterways are Getting Saltier. That's a Big Problem.

A salty chemical cocktail could make rivers and streams more corrosive, leading to dangerous effects.
Freshwater Salinization Syndrome: Concurrent trends in specific conductance, pH, alkalinity, and base cations
I. Causes of the Freshwater Salinization Syndrome?

II. Effects of Freshwater Salinization?
Causes of Freshwater Salinization

• Irrigation Runoff
• Potash, Lime, Fertilizers
• Mining and Strong Acid Inputs
• Industrial Brines
• Sewage
• Easily Weatherable Building Materials
• Road Salts
Causes of Freshwater Salinization

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Kaushal et al, 2017, Applied Geochemistry
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Jackson and Jaggoby, 2005, PNAS
Salinization outpacing urban growth

Corsi et al., 2015, Sci of the Tot Environ
Urban areas contribute to Salinization: Impervious surface coverage as a predictor

Kaushal et. al., 2017, *Applied Geochemistry*
Salting our freshwater lakes


Fig. 1. Chloride trends for North American freshwater lakes (circles and squares, n = 371). The states and province included in the NALR are outlined in black. Points are colored by the slope value of linear regression models (red, positive slope; yellow, negative slope; purple, zero or nonsignificant slope). Squares denote lakes with at least biennial chloride concentrations recorded from 1985 to 2010 (n = 56). These LTC datasets are a subset of lakes in the NALR, which is a region of dense sampling (n = 284). Upper inset of chloride time series from 1985 to 2010 are colored by slope value. Road salt application rates for North American provinces and states range from 0 to 35 US tons per mile and are shown in blue. No salt application rates were available in areas with hatched lines. The lengths of all individual datasets (dark green) as well as the lengths of LTC datasets (light green) are shown in the inset histogram.

Dugan et. al., 2017, PNAS
Freshwater salinization syndrome on a continental scale

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Kaushal et. al., 2018, PNAS
human-accelerated weathering

cation exchange
mineral dissolution

increased human inputs
road salts
agricultural lime
wastewater
fracking brines
mine drainage

biological alkalinization
primary production
microbial metabolism
(e.g. SO4 reduction, denitrification)

river outputs
drinking water contamination
mobilization of metals & nutrients
coastal ocean acidification buffer
decreased CO2 sequestration

total dissolved solids
specific conductance

pH

acids
alcaline

time

atmospheric inputs
weathering agents (H2SO4, HNO3, H2CO3)
cation deposition

geologic pools
rocks
soils
sediments

sedimentary lithology

the freshwater salinization syndrome

kaushal et. al., 2018, PNAS
I. Causes of the Freshwater Salinization Syndrome?

II. Effects of Freshwater Salinization?
Variation in Stream Salinity Pulses

Haq et al., 2018, In Review
Variation in Stream Salinity Pulses

Haq et. al., 2018, In Review
Lab Experiments to Characterize the Effect of Salinization: Sites

Haq et. al., 2018, In Review
Lab Experiments to Characterize the Effect of Salinization: Methods

Haq et. al., 2018, In Review
Salinization Mobilizes Nutrients from Sediment to Water Column

Haq et. al., 2018, In Review
Salinization Mobilizes Base Cations from Sediment to Water Column

Haq et. al., 2018, In Review
Salinization Mobilizes Metals From Watershed

Zehetner et. al., 2009, *Water Air Soil Pollut*
Salinization Mobilizes Metals From Watershed

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Changes in the Chemistry of Coastal Water

- Rates of coastal acidification and carbon dioxide evasion
- Amount and quality of carbon
- Effects on aquatic species and food webs
Solutions to the Salt Solution

• Source control
• Alternate de-icers and adaptive road salt application
• Rethinking stormwater infrastructure
Contact: Haq@umd.edu

Thank You!
Image Sources

5. https://www.washingtonpost.com/local/montgomery-residents-complain-about-brown-tap-water/2015/06/17/d7910098-146c-11e5-9518-f9e0a8959f32_story.html?utm_term=.c71701b4c21d