Extreme Events Alter the Future of Freshwater Salinization Syndrome

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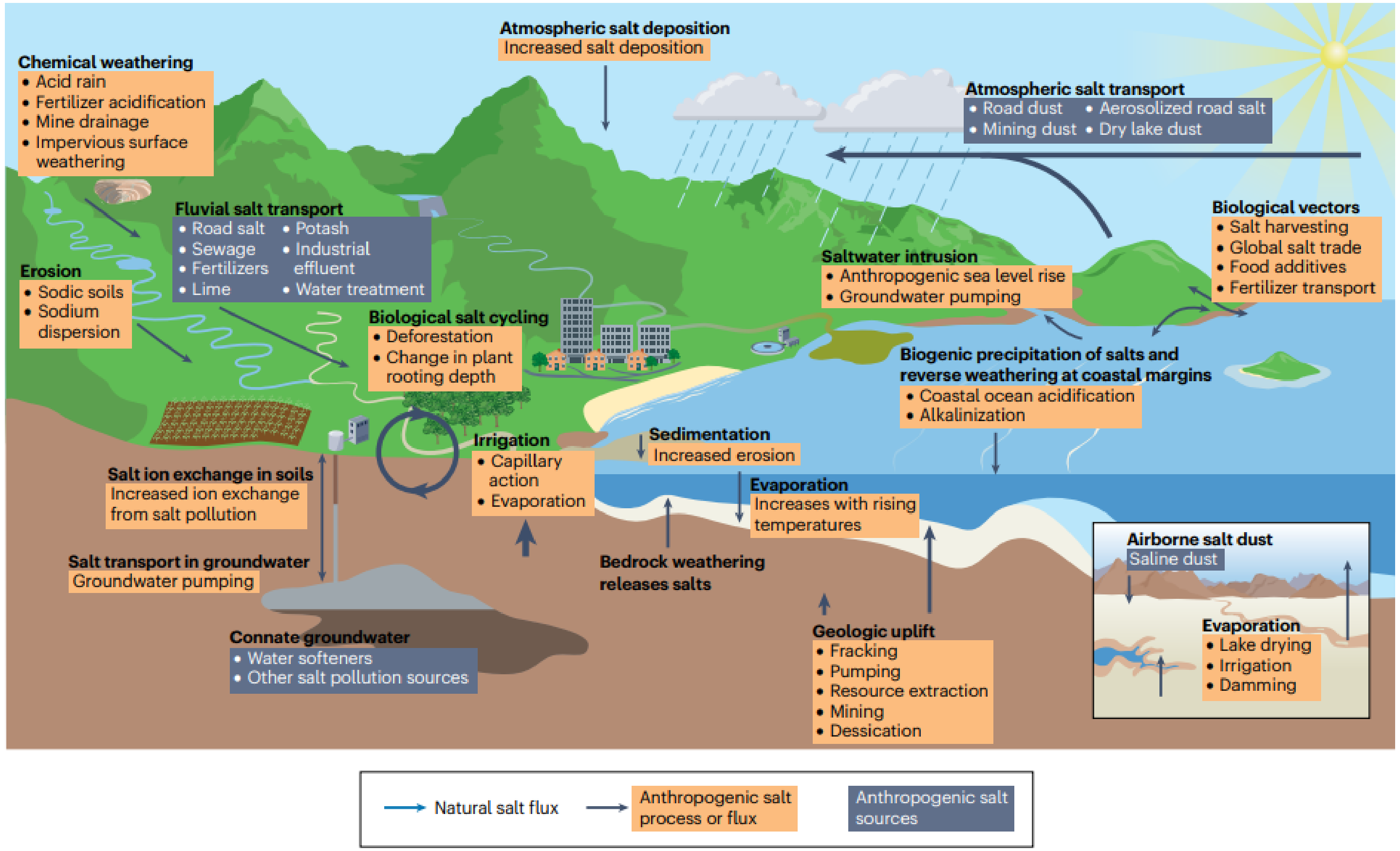
Acknowledgements:
Washington Metropolitan Council of Governments
National Science Foundation
U.S. Environmental Protection Agency
U.S. Geological Survey

Thanks WSSC for the Salt Summit!

Background

b The anthropogenic salt cycle



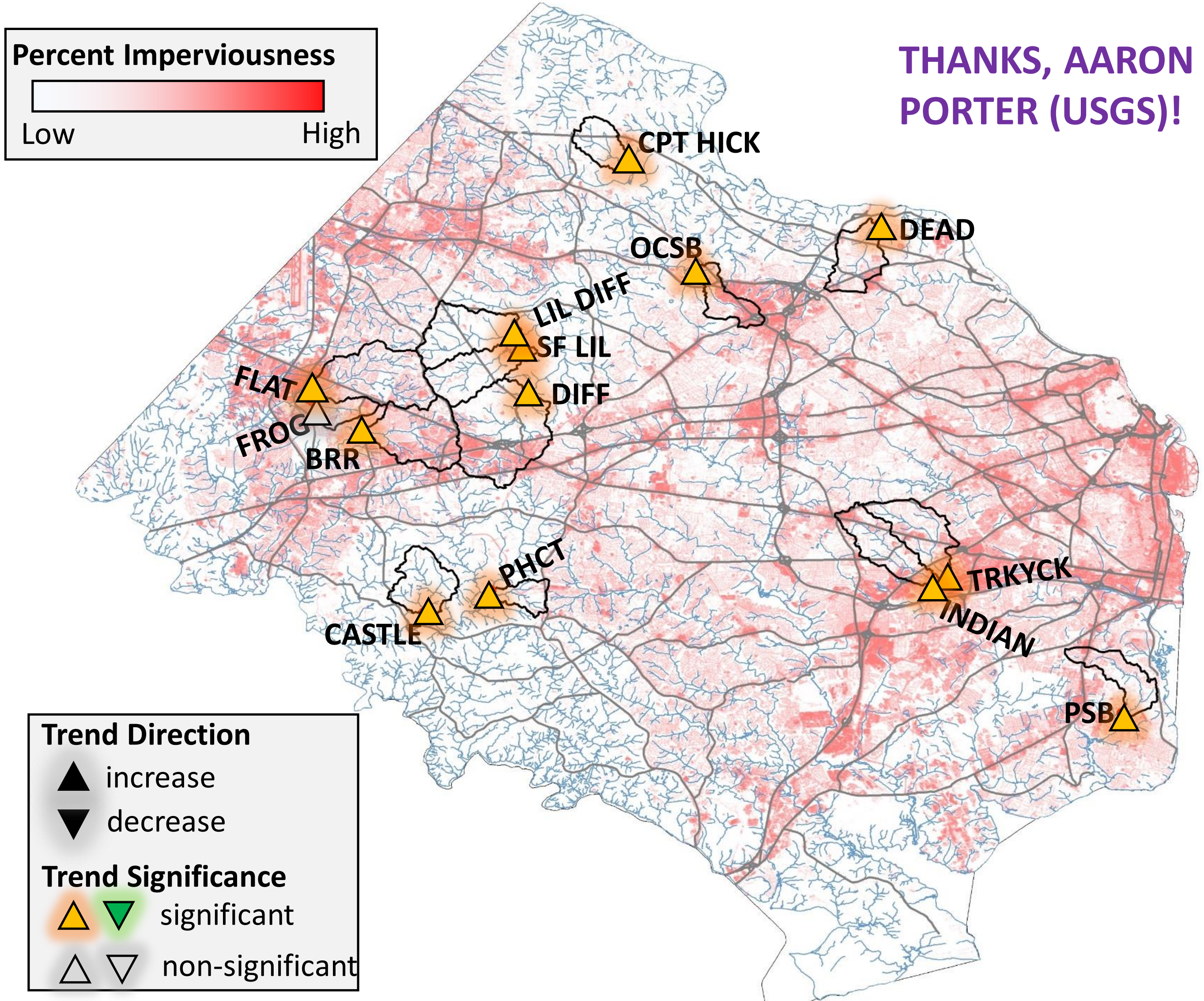
Kaushal et al. *Nature Reviews Earth & Environment* (2023)

Effects of climate change are complex

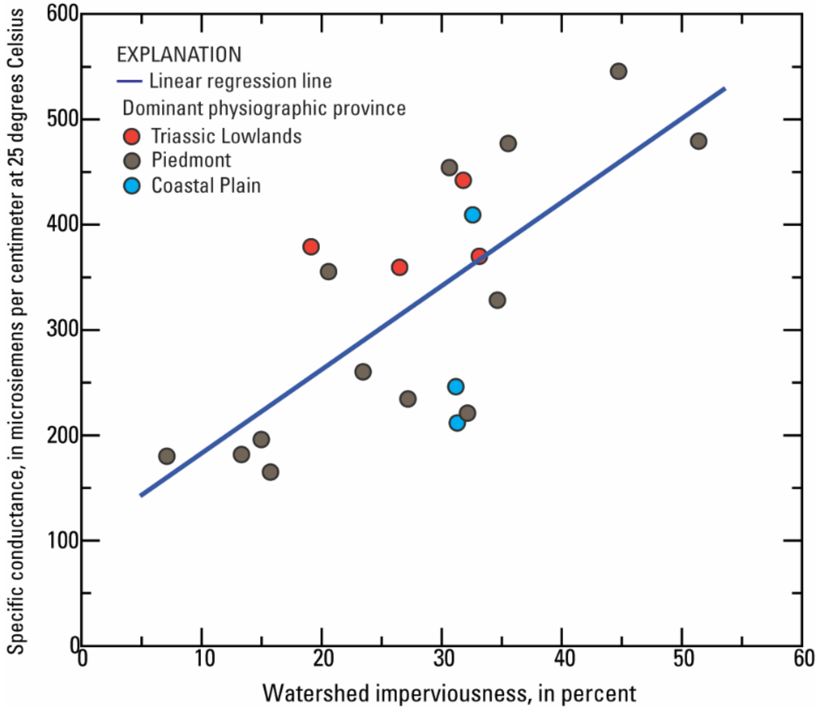
Extreme events are increasing over time

Salt is a tracer of intensification of the water cycle

Specific conductance increased throughout the monitoring network



THANKS, AARON PORTER (USGS)!



Specific conductance increases by about 2.5%, or 7.5 uS/cm/yr throughout the network.

These trends are likely related to the increased use of road salts and/or the increased delivery of road salts to streams.

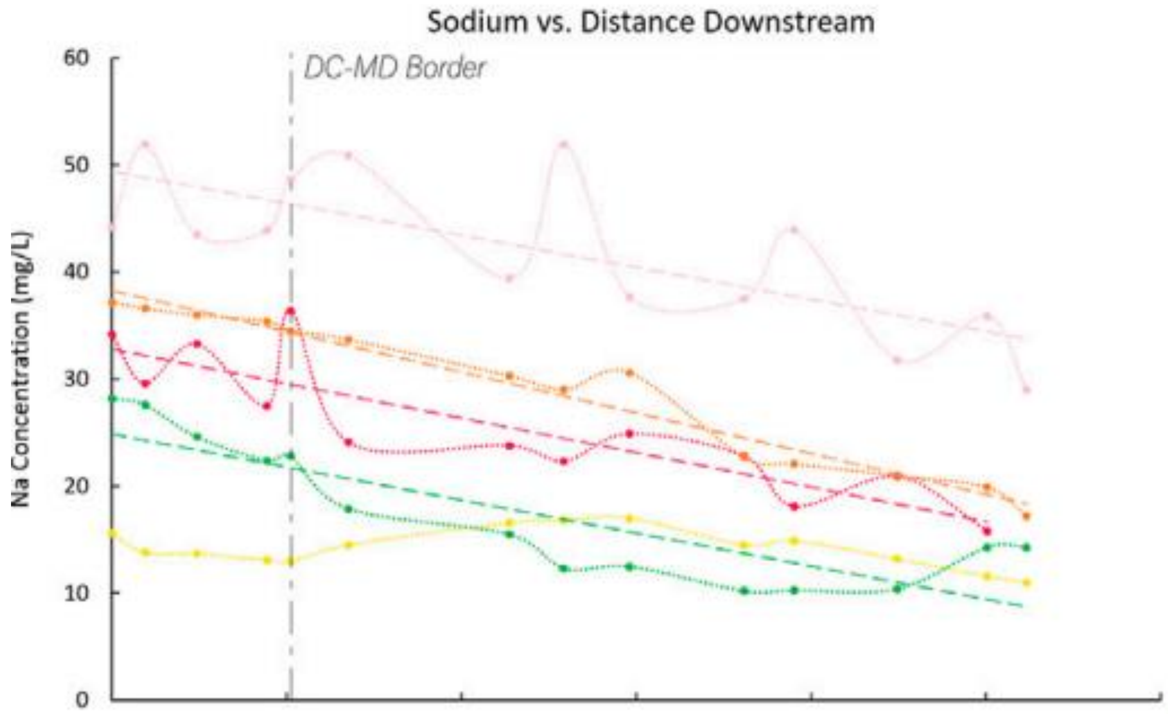
The largest increases occurred in the most impervious watersheds.

Porter and others, 2020, Spatial and Temporal Patterns in Streamflow, Water Chemistry, and Aquatic Macroinvertebrates of Selected Streams in Fairfax County, Virginia, 2007–18

2. Opposing Forces: Watershed Retention *vs.* Release

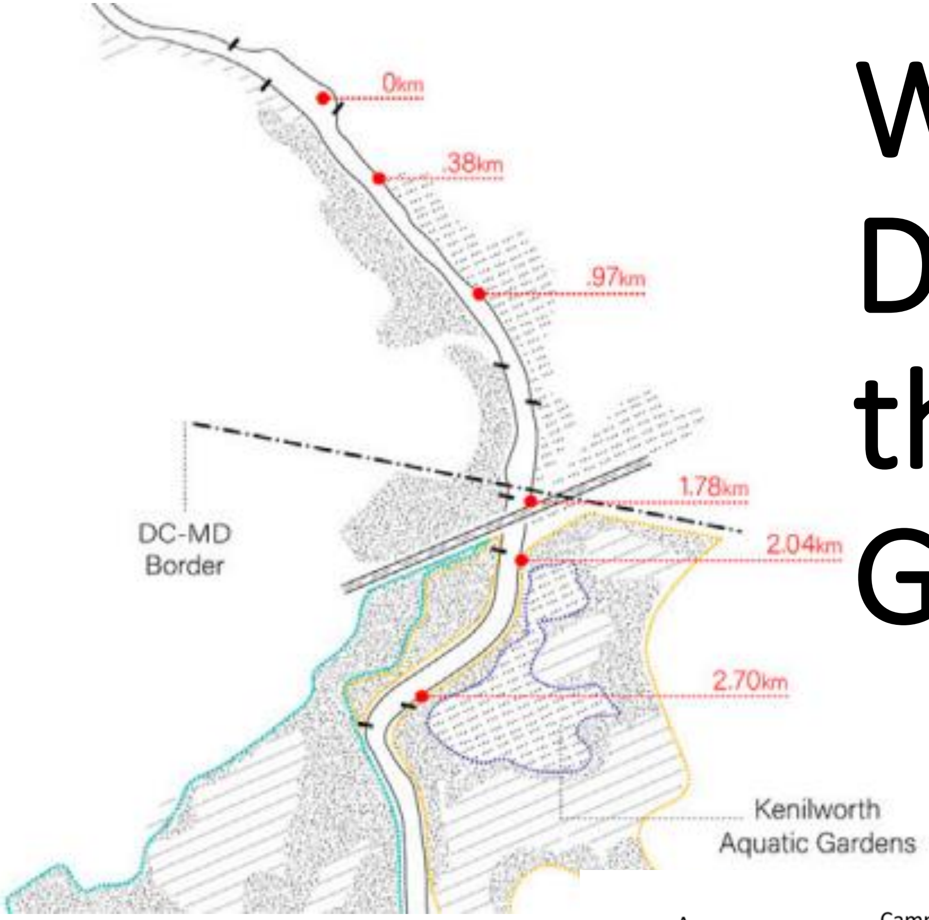
Are streams like salty pipes or reactors?

Where Does All the Salt Go?



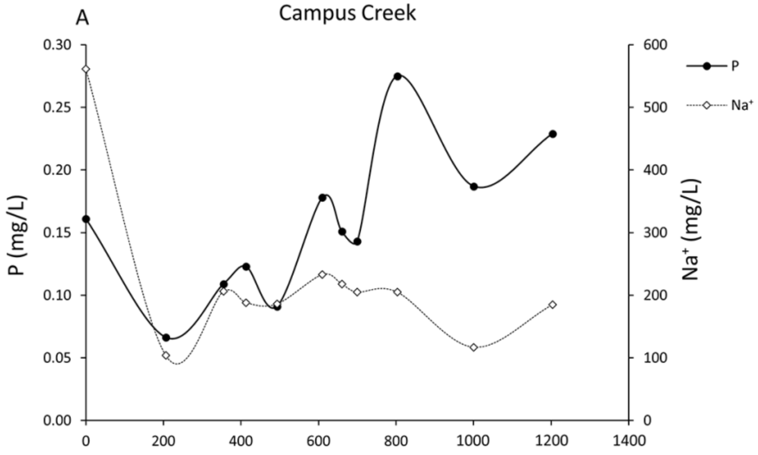
Distance Downstream

Kaushal et al. (2023)



Sodium and Chloride Can Be Retained: (Kaushal et al. 2022, Maas et al. 2023, Galella et al. 2023 a,b)

Salinization Mobilizes 'Chemical Cocktails': (Duan and Kaushal 2016, Haq et al. 2018, Kaushal et al. 2019, 2021, 2023, Morel et al. 2020, Galella et al. 2021, 2023a,b, Maas et al. 2023)

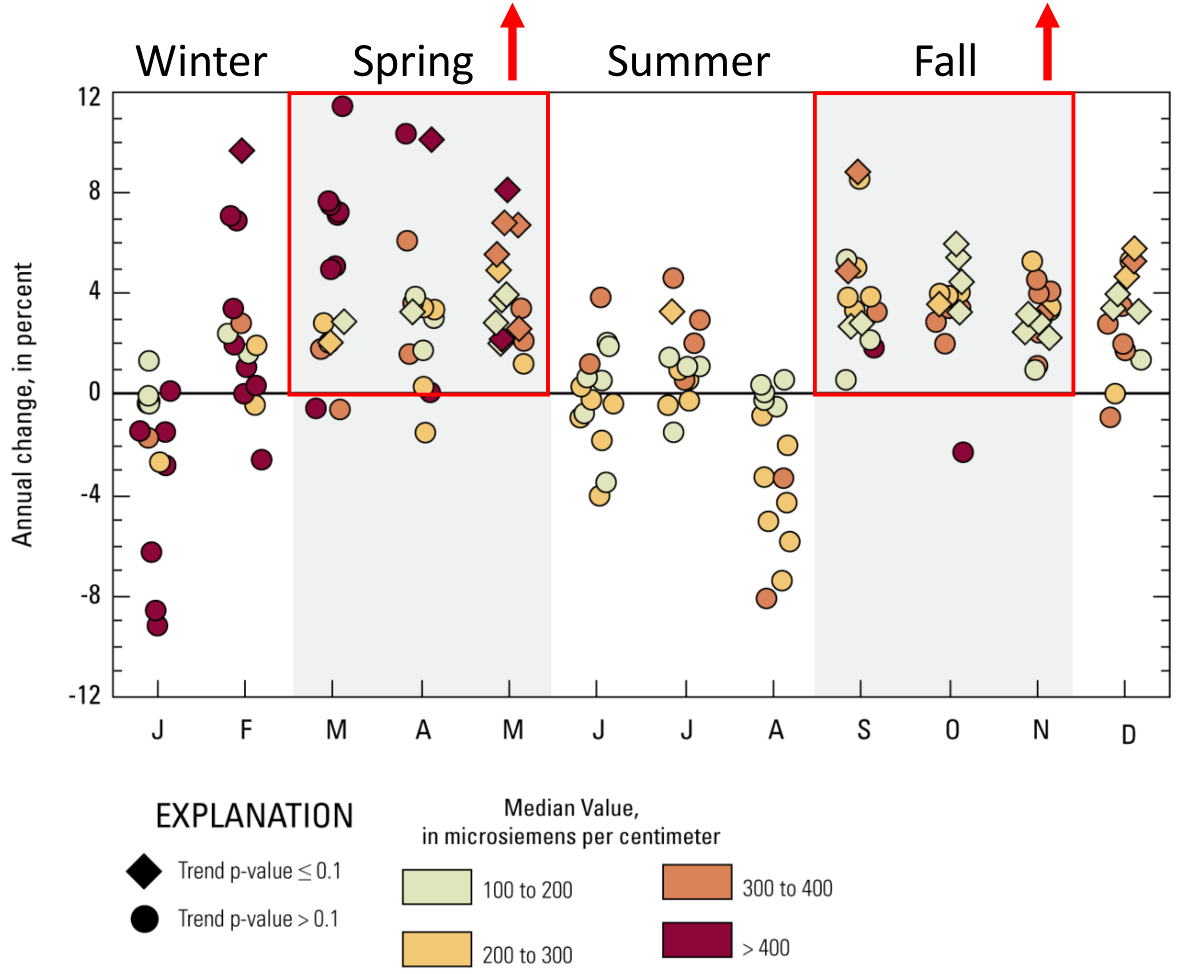


Kaushal et al. (2022) Distance Downstream

Specific conductance increased most in non-winter months

Significant increases were most consistently observed in **spring** and **fall** months

Increases in SC during nonwinter months suggest that salts applied to deice roadways and other impervious surfaces are stored in the environment and released year-round.
In **Spring** – wash off of salts applied in previous winter,
In **Fall** low flows allow release of salt contaminated groundwater

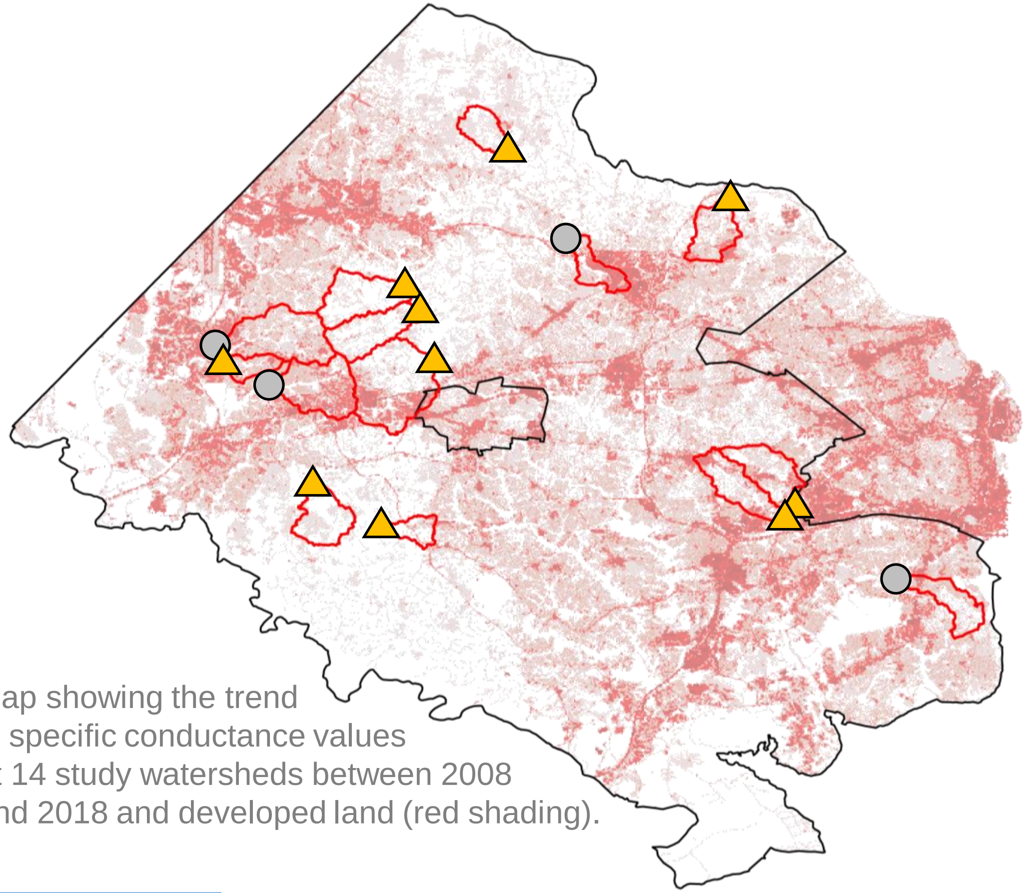


Specific conductance (SC) was likely related to the applied amount and storage of salt on the landscape

Observed Responses

SC values (on average, 150 – 500 uS/cm) declined in 0 (▼) and increased in 10 (△) study watershed between 2008 and 2018.

Other stations had no trend (●).



Map showing the trend in specific conductance values at 14 study watersheds between 2008 and 2018 and developed land (red shading).

Explanation of Variability

Developed Land

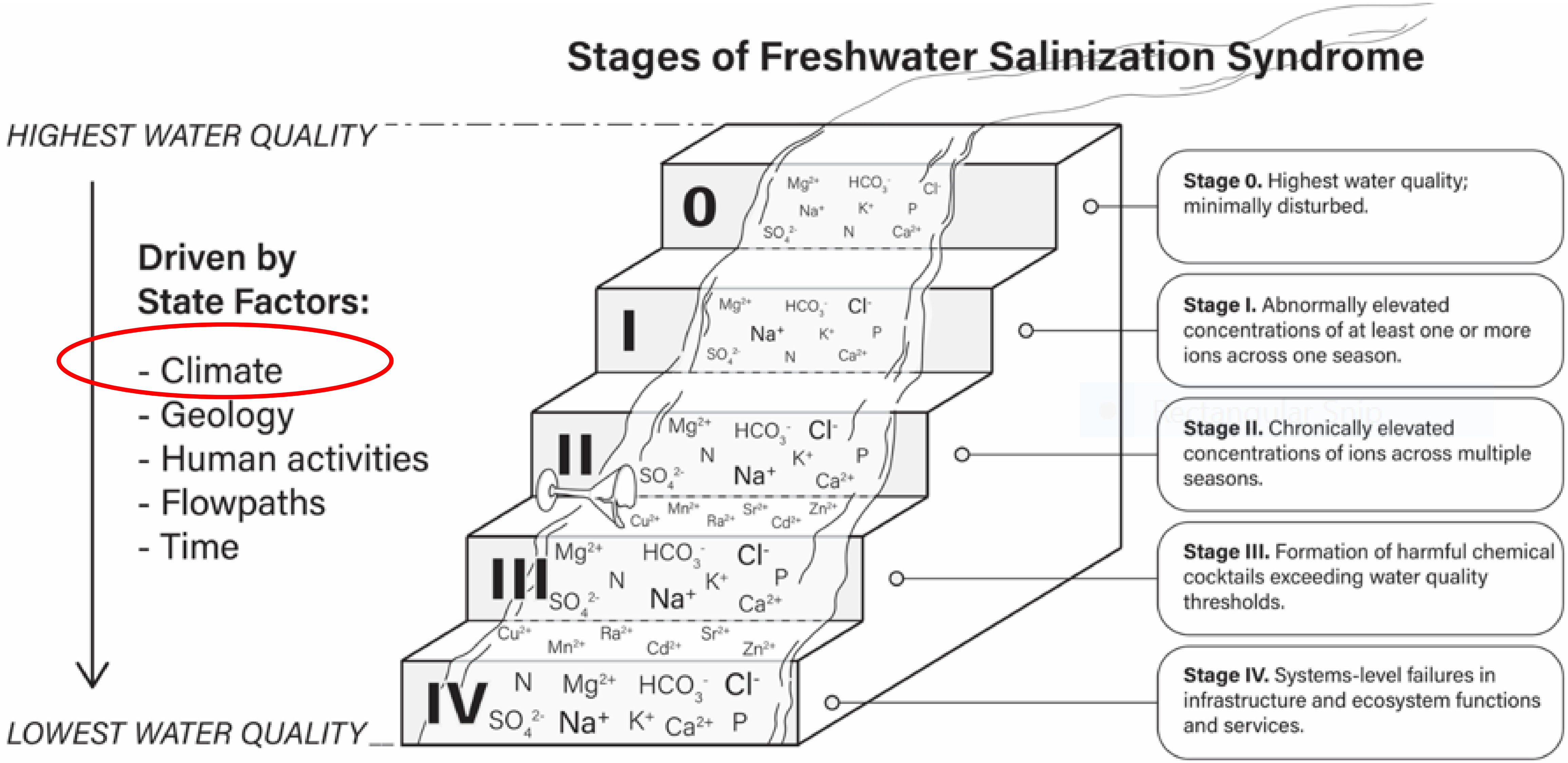
SC values were higher in watersheds with more developed land uses.

Soil Depth

SC values were higher in watersheds with more shallow soils.

Air Temperature

SC values were higher in years with colder minimum air temperatures.



Kaushal et al. 2023, *Limnology & Oceanography Letters*

Risks from Nontidal to Tidal Waters

Other Ongoing Efforts: Salt Tracking at Watts Branch

Problem: Salinization is impacting drinking water for the D.C. region. Watts Branch may be important, but there is lack of monitoring.

Action: Novel methods to track sources and amounts of salt pollution longitudinal monitoring and sensor proxies using electrical conductivity allow lower costs and wider capability of measurements during snow events and storms compared to traditional grab samples.

Partners: **THANKS KEN MACK, STEVE NELSON (LISA, STEVE, & COG!)**
Montgomery County Department of Environmental Protection installed electrical conductivity sensors. U.S. EPA is providing ion specific probes. Washington Metropolitan Council of Governments and UMD Grand Challenges are providing leveraging funds. UMD students, USGS, and Virginia Tech are collaborators.

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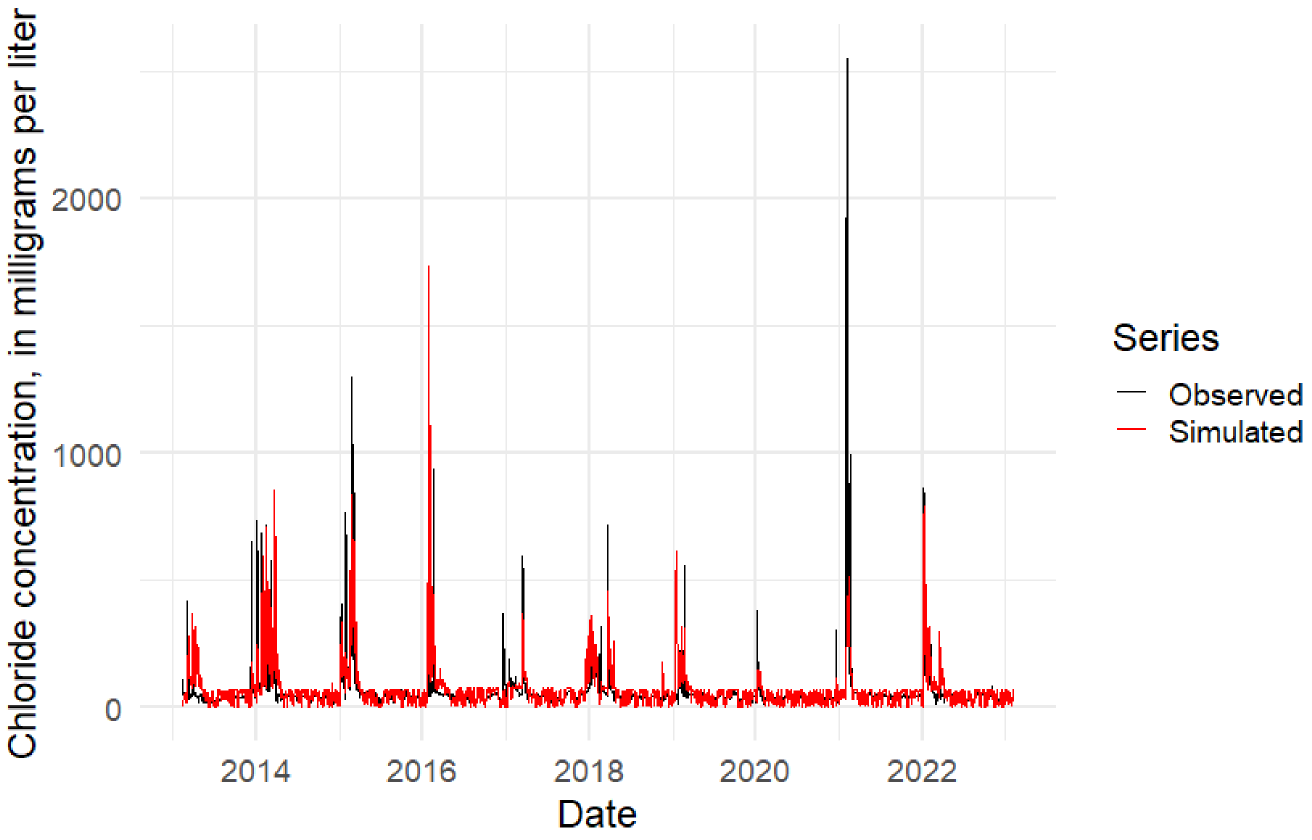
Other Ongoing Efforts: USGS Salt Prediction Tool

Observed versus simulated Cl^- (preliminary)



Long Branch (Fairfax County) Chloride Study

Conceptual model

1. *How much Cl^- is being exported in streamflow? What are the trends?*
2. *How much are we applying? What are the trends?*
3. *How much Cl^- is currently stored in the watershed?*
4. *What input reductions would be necessary to reach a specified reduction in export?*
5. *How long would it take for us to observe such a reduction?*

THANKS, JEFF CHANAT & AARON PORTER (USGS)

USGS

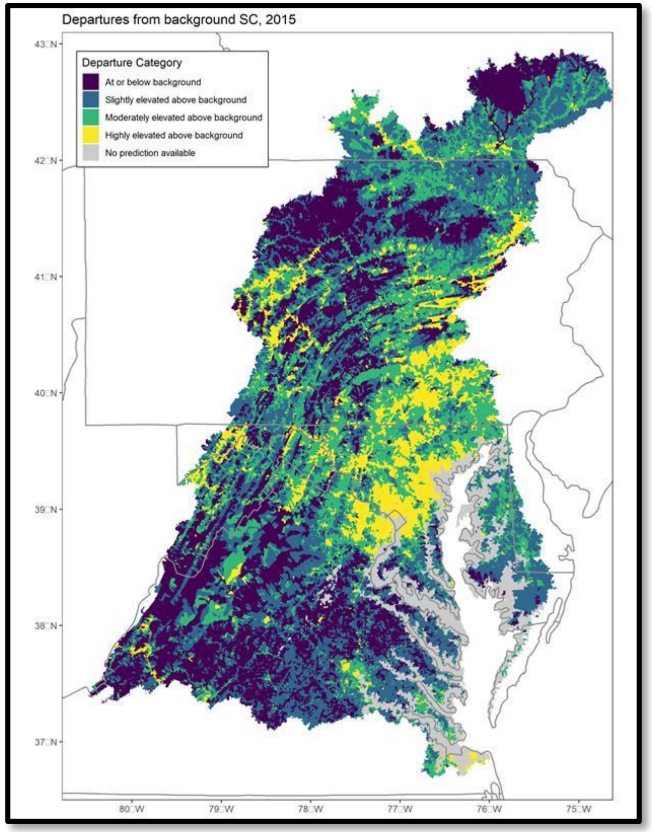
Other Ongoing Efforts: Developing spatially-referenced regional models

Monitoring and watershed-scale analyses can inform spatially-referenced regional models that:

- Expand our understanding of ***sources*** and ***processes***
- Estimate impacts of ***management practices***
- Predict conditions in ***unmonitored*** areas
- Assess ***risk/vulnerability***

Predictive modeling reveals elevated conductivity relative to background levels in freshwater tributaries within the Chesapeake Bay watershed, USA

Rosemary M. Fanelli, Joel Moore, Charles Stillwell, Andrew Sekellick, and Richard Walker (in review)

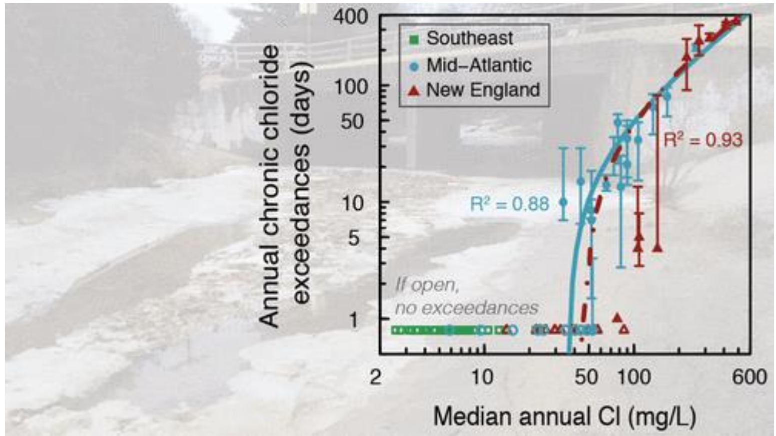


Thank you, Andrew Sekellick!

Environmental Science & Technology

High-Frequency Data Reveal Deicing Salts Drive Elevated Specific Conductance and Chloride along with Pervasive and Frequent Exceedances of the U.S. Environmental Protection Agency Aquatic Life Criteria for Chloride in Urban Streams

Joel Moore*, Rosemary M. Fanelli, and Andrew J. Sekellick



Other Ongoing Efforts: EPA ROAR Project

Collaboration among EPA Region 3, EPA Office of Research and Development, and UMD

- How does salinization relate to heavy metal and nutrient contamination?
- How can these salinization, heavy metals, and nutrients be monitored?
- How do different management strategies prevent these contaminants?

Sujay Kaushal, Steve Hohman, Virginia Vassalotti, Sydney Shelton, Paul Mayer, Patrick McGettigan (not pictured), Regina Poeske (not pictured)

THANKS EPA ORISE FELLOW: Sydney Shelton (UMD) and others!