TEMPORAL VARIATIONS IN CHLORIDE CONCENTRATIONS IN GROUNDWATER IN THE PIEDMONT PHYSIOGRAPHIC PROVINCE OF MARYLAND

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INTRODUCTION

The use of deicing salts has been shown to have significant impacts on surface and groundwater, resulting in degradation of aquatic life and threatening drinking water sources (Stranko and others, 2013). Baltimore County has had an increasing number of complaints regarding high-chloride wellwater (K. Koepenick, written commun., Baltimore County Department of Environmental Protection and Sustainability, 2015; Ensor, 2016).

Chloride is difficult to remove from water, often requiring reverse osmosis. This process is expensive, requires large amounts of water, and generates highly concentrated waste which must then be disposed of. High-chloride water can damage plumbing fixtures, appliances, and pipes. Since chloride is unreactive, it does not degrade in the environment. Additionally, the impacts of these salts on the mobilization of trace elements, heavy metals, and adsorbed contaminants in Maryland groundwater have not been adequately evaluated.

From the 1970's to the early 2000's, the Maryland Geological Survey (MGS) sampled many wells in the Maryland Piedmont, testing the water samples for chloride and other major ions and constituents. These data provide a valuable baseline against which future water-quality samples can be compared to monitor changes in groundwater chemistry.

SOURCES OF CHLORIDES

Road salt applied during winter precipitation events make up **43.5%** of all salts consumed by the US*

Agricultural ammendments such as fertilizers, pesticides, and animal feed additives make up **2.5%** of all salts consumed by the US*

Water treatment systems, such as water softeners and reverse osmosis make up **1.4%** of all salts consumed by the US*

*Other salt use is from chemical processes, distributors, food processing (USGS, 2017)

ADVERSE EFFECTS

Not Regulated: Chloride does not have an EPA Maximum Contaminant Level, but has a Secondary Maximum Contaminant Level of 250 mg/L.

High Sodium: Elevated chloride is often associated with elevated sodium, which can exceed dietary restrictions for some individuals with hypertension.

Elevated Chloride may also cause:

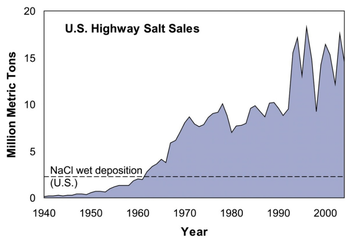
Water to develop salty taste

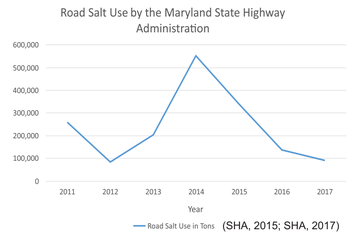
Costly water treatment systems

Well integrity to be compromised

Corrosion to pipes and household appliances

HISTORY OF ROAD SALT USE



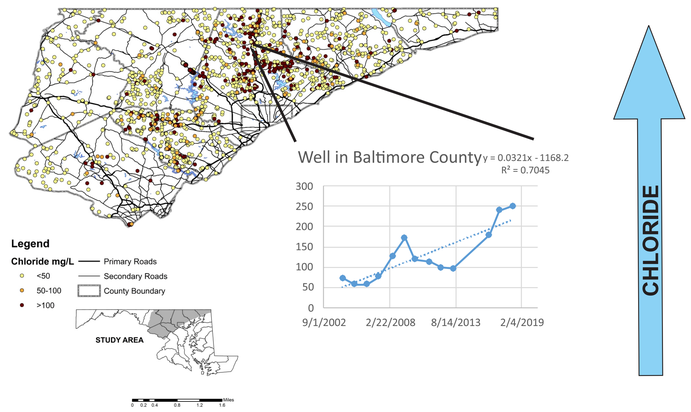


(SHA, 2015; SHA, 2017)

"While the cost of damage to bridge decks and vehicles is high, but reversible, the damage to health many not be reversed. We can no longer afford to ignore the fact that we are depositing large quantities of salt into the water that nature provides us and upon which [we] are dependent every moment of our lives. The most advanced medical research indicates that water with more than 20 mg/L sodium is unhealthy and detrimental to a substantial fraction of the population. The American Heart Association supports this fact. Disregard for the quality of drinking water in this and any instance is extreme negligence and we must face the issue squarely. Road salt may be only one of the many serious pollutants in our environment, but that is no excuse to allow the present situation to exist any longer. In order to avoid further damage and high costs, salt use to winter maintenance must be reduced in many areas." - EPA, 1976

CURRENT TRENDS IN THE PIEDMONT

CHLORIDE CONCENTRATIONS ARE INCREASING



ACKNOWLEDGEMENTS

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USGS science for a changing world

Thank you to Baltimore, Cecil, Carroll, Frederick, Harford, Howard, and Montgomery Counties for supplying chloride data.

MGS 2018-2020 CHLORIDE STUDY

1 TARGETED WELLS

A. Areas with high chloride, most likely already impacted by road salts

B. Areas with low chloride, not likely to change

C. Areas with low chloride, likely to change

2 RE-SAMPLE WELLS

MGS will resample wells that were analyzed from the 1970's to the early 2000's for chloride as well as other constituents. These samples will allow us to evaluate changes in chloride concentrations over time.

3 ANALYZE RESULTS

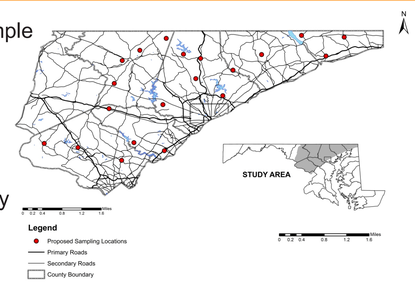
Can we predict where elevated chloride concentrations occur (well depth, distance to road, etc.)?

Are there any trends or relationships between chloride and other constituents?

NEXT STEPS IN THE STUDY

1. Identify additional wells to sample Collect samples and submit to USGS lab

2. Identify well for conductivity probe installation - continuous monitoring of specific conductivity for two years



Samples will be analyzed for the following constituents:

Major ions and indicators

- Calcium
- Magnesium
- Sodium
- Potassium
- Nitrate + Nitrite
- Ammonium
- Alkalinity
- Sulfate
- Chloride
- Fluoride
- Bromide
- pH
- Specific Conductance
- Total Dissolved Solids

Trace Elements and Radionuclides

- Antimony
- Arsenic
- Barium
- Beryllium
- Cadmium
- Iron
- Manganese
- Selenium
- Thallium
- Lead
- Gross-alpha-particle activity
- Gross-beta particle activity
- Uranium
- Radon

REFERENCES

Stranko, S., Bourquin, R., Zimmerman, J., Kashiwagi, M., McGinty, M., & Klauda, R., 2013, Do road salts cause environmental impacts? Maryland Department of Natural Resources. Retrieved from: http://www.dnr.state.md.us/streams/pdfs/RoadSalt2013.pdf

Ensor, Bill., 2016, Observed Impacts of Chlorides in Baltimore County, Maryland Water Monitoring Council Road Salt Workshop.

U.S. Environmental Protection Agency, 1976, An economic analysis of the environmental impact of highway de-icing, Environmental Protection Technology Series, EPA-600-2-76-105

U.S. Geological Survey, 2017, Minerals Yearbook [Salt] - 2015

Maryland State Highway Administration, 2017, The Maryland Department of Transportation State Highway Administration (MDOT SHA) -- Winter Operations Facts and Figures 2017-2018 Winter Season

Maryland State Highway Adminstration, 2015, The Maryland Department of Transportation's State Highway Administration (SHA) -- Winter Operations Facts And Figures 2015-2016 Winter Season

FIGURES
https://mashable.com/shopping/nov-2-money-management-service/
https://www.griswoldplumbingct.com/signs-of-water-heater-malfunction/
https://multiplesclerosisnewstoday.com/2018/11/05/salt-appearts-to-trigger-inflammation-promote-autoimmune-disease-though-impact-on-t-cells-study-shows/
https://mde.maryland.gov/programs/marylander/pages/roadsalt.aspx
Jackson, R. B.; Jobbágy, E. G., 2005, From icy roads to salty streams. Proc. Natl. Acad. Sci. U.S.A., vol. 102, pp. 14487–14488.
https://www.rti.org/practice-area/food-security-and-agriculture
https://www.freedrinkingwater.com/ro-90-detail.htm?gclid=EAIaIQobChMI5K2Wy8Tg3gIVkVmGCh2B4wVLEAQYCiABEgK7FfD_BwE