Road salts contribute to lead leaching from plumbing, and mobilization of heavy metals and radionuclides in ground and surface waters.

Impacts of deicing salt use on metal and radionuclide mobilization – implications for ground and surface water quality

Andrew Lazur
University of Maryland Extension

INTRODUCTION

- Salt is the main tool for deicing roads in the U.S., with use with use increasing exponentially since the 1940's.
- Approximately 22 million tons of salt is applied to roads in the US and 91,000 tons were used in Maryland in the 2017-18 winter.

Research has reported:

↑ Chloride/sodium in ground and surface waters
↑ Miles of rivers or streams impaired (~ 3K in mid-Atlantic)
↑ Leaching of dissolved organic C
↑ Leaching of nitrogen
↑ Sodium and soil dispersion
↑ Mobilization of soil base cations
↑ Corrosivity on plumbing and lead
↑ Mobilization of heavy metals and radionuclides
↑ Risks to public health

↓ Aquatic species populations and diversity
↓ Soil pH
↓ Soil organic matter
↓ Soil microbial decomposition
↓ Soil permeability
↓ Drinking water quality

CORROSIVENESS

- Chloride to sulfate ratios (CSMR) > 0.5 are corrosive
- Flint, MI lead crisis due to CSMRs going from 0.45 to > 2.0 with water source and treatment change
- Virginia study showed 89% of wells had CSMR > 0.5
- Costs >$30 billion/year damage to public water supply infrastructure
- Damage to private home plumbing is estimated at more than twice that of public water supply

HEAVY METAL MOBILITY

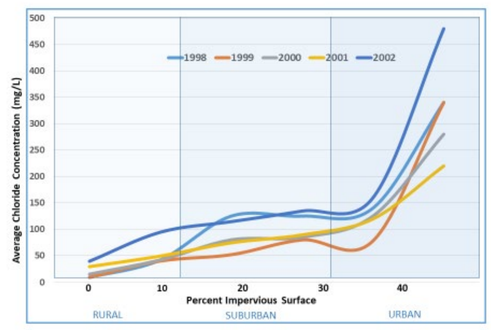
- Chloride induced metal mobilization mechanisms due to ion exchange, pH decrease, formation of complexes, and colloidal transport
- Chloride complexes greatest with Zn, followed by Pb, Cd and Hg
- Cr, Pb, Ni, Fe, and Cu leaching increases as salt increases mostly due to OM mobilization
- Higher soil organic matter increases metal retention

MOBILIZATION OF RADIONUCLIDES

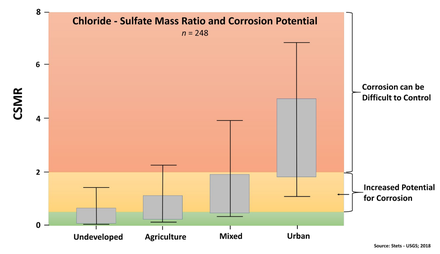
- EPA has established MCL's for radionuclides as follows: gross alpha particle - 15 picocuries per liter (pCi/L); radium-226 and radium-228 - 5 pCi/L; and uranium - 30 micrograms per liter (µg/L).
- A national study of 94 wells from public water supplies, Focazio et al. (1998) observed that 21 samples exceeded the current combined radium standard
- Bolton (2000) tested 203 wells in MD and observed that radium-226, radium-228, gross alpha particle and gross beta particle activity increased with increasing total dissolved solids and sodium and chloride concentrations. All the samples having greater than 10 and 15 mg/Liter sodium and chloride respectively had radium-226 plus radium-228 concentrations greater than the MCL of 5 pCi/L picocuries per liter

CONCLUSIONS

- Accumulating salts in both ground and surface waters increases risks of metal and radionuclide exposure to ecosystems and drinking water requiring expanded action
- Actions include enhanced voluntary adoption of proven salt reduction practices, or regulations to require practices and engagement of the entire community in deicing activities



Average annual stream chloride concentration and percent impervious surface in Baltimore area watershed (adapted from Kaushal et al. 2005).



Corrosion potential based on Chloride to Sulfate Mass Ratio (CSMR) for various land uses.

Anti-icing or pre-wetting with salt brine prior to storms is one of several salt management practices used to reduce salt application.

Water quality testing including first draw and 3 minute flush is required to determine influence of corrosion on presence of heavy metals in drinking water.

References

Bolton, D.W. 2000. Occurrence and distribution of radium, gross alpha-particle activity, and gross beta-particle activity in ground water in the Magothy Formation and Potomac Group Aquifers, Upper Chesapeake Bay Area, Maryland. Maryland Geological Survey Report of Investigations No. 70.
Edwards, M. and S. Triantafyllidou. 2007. Chloride-to-sulfate mass ratio and lead leaching to water. Journal AWWA 99(7):96-109.
Focazio, M.J., Z. Szabo, T.F. Kraemer, A.H. Mullin, T.H. Barringer, and V.T. DePaul. 1998. Occurrence of selected radionuclides in ground water used for drinking water in the United States: a targeted reconnaissance survey, 1998. US Geological Survey Water-Resources Investigations Report 00-4273.
Kaushal, S. S.; Groffman, P. M.; Likens, G. E.; Belt, K. T.; Stack, W. P.; Kelly, V. R.; Band, L. E.; Fisher, G. T. 2005. Increased salinization of fresh water in the northeastern United States. Proc. Natl. Acad. Sci. U.S.A. 102:13517–13520.
Stets, E.G., C.J. Lee, D.A. Lytle, and M.R. Schock. 2018. Increasing chloride in rivers of the conterminous U.S. and linkages to potential corrosivity and lead action level exceedances in drinking water. Science of the Total Environment 613–614:1498–1509.
* Additional references found in draft review article available through QR code below

UNIVERSITY OF MARYLAND EXTENSION