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Increased Salinization Decreases Safe Drinking Water

Sujay S. Kaushal*

Department of Geology & Earth System Science Interdisciplinary Center, University of Maryland, College Park Maryland 20740, United States

Over decades, there has been increased salinization of fresh water in many regions of the world. Salinization was previously thought to be an environmental problem restricted primarily to arid regions. However, it is now recognized as a global environmental concern impacting humid regions due to human inputs from road deicers, sewage inputs, and water softeners (Figure 1). In both arid and humid regions, there can be "natural" variations in geologic sources of salts due to chemical weathering. Recently, it has been suggested that human activities have contributed to accelerated weathering of geologic sources and additional inputs of salinization.[1] Thus, both human inputs and accelerated weathering are contributing to the increased salinization of fresh water.[1,2] Increased salinization can impact drinking water through leaching of contaminants in soils, sediments, and water infrastructure.[3−5] For example, corrosion of water infrastructure influenced by road salt has recently been linked to lead contamination in drinking water in Flint, Michigan. Deicers can also contain impurities and toxic anticaking agents.[3] Despite these and other concerns regarding drinking water contamination, salt concentrations are not currently regulated by the U.S. Environmental Protection Agency. Given widespread increasing salinization trends, federal regulation of salt concentrations could lead to better management aimed at reducing impacts to drinking water and aging infrastructure.

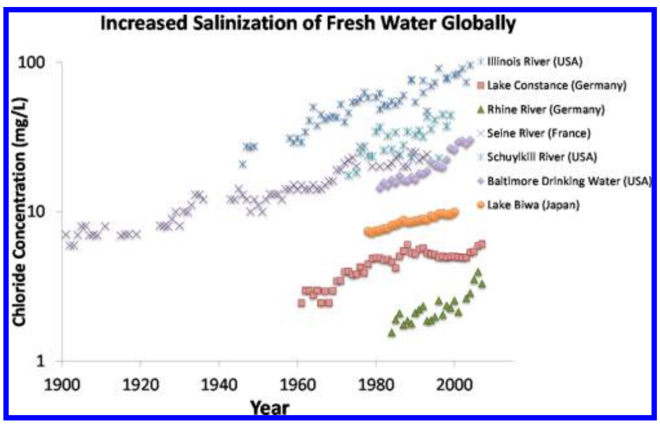

Figure 1. Previous work has suggested increased salinization of fresh water is now a global issue. There have been increasing trends in annual chloride concentrations in freshwater ecosystems over decades.

In northern regions, salinization of fresh water is significantly related to increasing impervious surface cover in watersheds.[2] In addition to geologic sources and other human inputs, salinization increases as deicer is applied to impervious surfaces to promote safe transportation. During winter months, salt concentrations in urban waters can spike up to approximately 25% the salinity of seawater.[2] It can take weeks and months for these salt pulses to diminish, and salt concentrations can remain chronically elevated during summer months.[2] Interestingly, long-term baseline concentrations of salts have increased in fresh water, even during seasons when deicer is not applied.[2] These widespread trends are due to the accumulation of salts stored in soils and groundwater. Thus, even if road salt applications ceased, many freshwater ecosystems would still remain chronically salinized for decades. Increased salinization of fresh water now represents a chronic environmental problem.[2]

In watersheds, salinization of fresh water enhances mobilization of contaminants from soils and sediments.[3,4] It is well-known that sodium from road salts can displace toxic metals and base cations from ion exchange sites on soils and sediments.[3,4] For example, toxic metals such as copper, lead, and zinc are released from soil exchange sites near streams following applications of road salt.[3] In response to salinization, organic carbon can be released from changes in soil structure, microbial decomposition, and desorption.[4] Salinization enhances leaching of organic carbon from soils and sediments, which can increase disinfection byproducts in fresh water. In addition, salinization enhances leaching of organic nitrogen, ammonium, and phosphorus from ion exchange sites on soils.[4] Mobilization of nitrogen and phosphorus to drinking water supplies can further contribute to eutrophication. Overall, increased salinization of fresh water enhances mobilization of previously

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Environ. Sci. Technol. XXXX, XXX, XXX−XXX

entrained contaminants from soils and sediments, which can negatively impact drinking water quality.[3,4]

Increased salinization of fresh water can contribute to leaching of metals from aging water infrastructure and sediments in pipes.[5] Given that water infrastructure deteriorates over time, water supplies in older cities may be more at risk. Leaching can occur when water with dissolved salts displace metals from sediments in pipes or corrode the pipes themselves. Overall, the result can be increased concentrations of metals in water distributed through piped systems.[5] Comprehensive detection of metals leaching from pipes to houses can be complex and requires awareness and monitoring throughout distributed pipe networks. Leaching of metals from water infrastructure and sediments has contributed to recent well-publicized incidents of increased lead concentrations in drinking water in Flint, Michigan and increased manganese concentrations in drinking water in the Washington, DC metropolitan area. Interestingly, partial replacement of lead pipes with copper in Flint, Michigan and Washington, DC may have more than doubled lead leaching into water due to chemical reactions.[5] Thus, increased corrosion and leaching of sediments in aging water pipes associated with salinization represents a serious health, economic, and engineering issue.

Currently, salt content of fresh water is not regulated by the U.S. federal government. For example, a recommended level of 250 mg/L of chloride has been set by the U.S. Environmental Protection Agency. However, streams in northern latitudes often exceed this value during winter months when deicer is applied.[2] Other countries such as Canada regulate road salt as a toxic substance, which requires minimizing use and reducing release into the environment. Sodium chloride, calcium chloride, and magnesium chloride are commonly used road salts. Road salt contamination of potable water may already be a concern for some people with health issues, for example, those needing dialysis to maintain their kidneys and those on sodium restricted diets. Even when salt concentrations may not pose a direct health risk, the leaching of contaminants from watersheds and water infrastructure in response to increased salinization does. Properly executed best management practices for salt applications can significantly reduce salt applications, but may also require rigorous training and federal regulation of salt concentrations to be more widely implemented. Currently, best management practices include: selection of road salts based on temperature/melting point, presalting of roads, using brines, and improved calibration/salt delivery techniques. Alternative deicers using organic materials (e.g., beet juice) have also been proposed. However, these alternative organic deicers could contribute to unanticipated water quality problems such as increased oxygen demand and contaminant binding. Ultimately, monitoring and reducing road salt is necessary along with improved planning strategies for minimizing impacts to fresh water. Given increasing salinization trends, regulations may be needed to reduce risks associated with the health and economic impacts of saltier fresh water.

AUTHOR INFORMATION

Corresponding Author

*E-mail: skaushal@umd.edu.

Notes

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Environ. Sci. Technol. XXXX, XXX, XXX−XXX