USING WETLANDS TO REDUCE THE EFFECTS OF SODIUM CHLORIDE ON WATER AND SOIL HABITATS

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Since World War II, significant increases in sodium chloride (NaCl) uses, particularly for deicing and water softening, have caused chloride concentrations in our surface and ground waters to markedly increase. A study conducted by the United States Geological Survey (Mullaney, 2009) showed that road-salt and other anthropogenic uses of chloride are important factors affecting the biological integrity of urban streams in the northern United States). A more recent study by the Illinois State Water Survey (Kelly, 2012) reported that within the last decade an estimated 250 metric tons/year of rock salt were applied in the Chicago metropolitan area alone.

The United States Environmental Protection Agency (USEPA) has set the chronic criterion for aquatic organisms based on a four-day average concentration of 230 mg/L occurring every three years and an acute criterion of 860 mg/L for a one-hour period occurring less than every three years. It only takes one teaspoon of rock salt in 5 gallons of water to reach the USEPA chronic criterion of 230 mg/L. Remember, NaCl is very soluble so it is difficult to remove.

The Illinois Environmental Protection Agency (IEPA) considers a surface water impaired if chloride concentrations exceed an acute criterion of 500 mg/L. Recent studies have uncovered that this standard would not be met for most surface waters in the state of Illinois. In 2018, the IEPA stated in their Integrated Report that 472 stream miles have chloride concentrations greater than 500 mg/L; therefore, the agency considers these streams to be impaired by chloride. Included among these streams is the South Branch of the Kishwaukee River (PQI-H-C5) in McHenry County, which represents 4.29 miles.

In a study conducted on Honey Creek in southeastern Wisconsin (SEWRPC, 2016), average chloride concentrations were reported to be between 1,917 mg/L Cl^- and 3,742 mg/L Cl^-, which exceeded the chloride concentration of 1,400 mg/L found lethal to 50% of test organisms in a 96-hr toxicity test. In urban areas, southeast Wisconsin streams had chloride concentrations recorded as high as 10,000 mg/l as a result of winter deicing practices.

While NaCl is not toxic to humans, the US EPA has a secondary standard for drinking water of 250 mg/L Cl^-, which is related to taste. It is corrosive to steel and may corrode pipes in water treatment and industrial plants and is destructive to concrete. Elevated Cl^- levels in drinking water supplies result in salty tasting water and may cause shifts in algal populations favoring blue green algae (cyanobacteria), both leading to increased treatment costs. Blue-green algal blooms have the potential to be harmful to human health if humans are exposed and are aesthetically unpleasing leading to reduced recreational opportunities.

Today, governmental agencies spend approximately $60 to $70/ton of rock salt and then invest approximately $20 billion dollars annually to replace infrastructure damage from salt spray to infrastructures, vehicles and equipment. Many communities are educating their public works staff on best management practices of salt application, using anti-icing chemicals such as Supermix and beet juice and using pro-active techniques based upon storm conditions (i.e. temperature, timing, etc.) The communities employing these practices have saved a significant amount of money by reducing the amount of salt required to make passageways safe. However, the products used remain chloride based.

Due to the solubility of chloride, WRI investigated a suite of wetland plants they suspected or are known to be salt tolerant. They identified one species whose mean above ground biomass contained 31,400 mg/kg dry Cl^-. WRI hypothesizes that certain plants will uptake enough chloride from surface and soil water which, when digested, will produce methane gas and salt water. The first byproduct can be used to produce electrical energy and sold while the other can be used as a replacement for beet juice or used as an active agent in the Supermix blend.

We propose to implement a 3 to 5-year research project that will tests the hypothesis that there is no difference between current winter maintenance practices and using the water from recycled native wetland plants as a beet juice or Supermix substitute. Further, the use of appropriate native vegetation will reduce the chloride reaching surface and groundwater within the test watershed. The research project would require locating replicate plots that could be prepared and appropriately propagated along highways or roads in the county and serve as drainageways conveying surface runoff. The vegetation would be harvested at the end of the growing season and brought to an anaerobic digestion facility where it would be processed and the processed water byproduct from the process collected and analyzed for chloride concentration. Public works departments would be able to use the process water for pre-wetting or as a component of the Supermix blend.

Once we have land allocated for the test plots, we will be able to give a more detailed implementation schedule. The details and cost will be defined once the research sites have been identified. As part of the research project, WRI would investigate the economics of current practices and that using the recycled native wetland plants. WRI anticipates that public works departments will save money by using native plants to meet their winter maintenance needs and can meet chloride standards implemented by the IEPA as part of NPDES permits. Finally, the various public works department will be able to use the methane production to meet electrical energy needs for their facilities and others.

The research program will span five years. The first year will involve establishing the appropriate vegetative cover at the test sites and conducting a baseline survey of the sodium chloride and organic concentrations in plants and soils. We will continue the related monitoring program for the research period. In year 2, we will develop specifications for the digester and a site for its construction. We will begin to collect the effluent from digestion and to determine its usefulness as a deicing alternative. In the final two years WRI will continue monitoring activities and will start and finish the research report.

The following is the proposed research program outline:

1. Wetland plants to remove chloride
   a. Site Selection
   b. Study design
   c. Site Clearing
   d. Planting/Seeding
   e. Maintenance (watering to establish, if necessary)
   f. Harvesting in September/October
   g. Digestion
   h. Analyses of byproducts (water, sludge)
2. Methane production
3. Chloride reduction
4. Economic Analyses

a. Current deicing best management practices
    i. Material costs
    ii. Operation and Maintenance
    iii. Equipment Upgrades
    iv. Capital and operating costs
b. Digestor
    i. Location (minimize haul of fuel and optimize electrical grid connection)
    ii. Design
    iii. Construction
    iv. Operational performance
    v. Capital and operating costs
c. Biological component
    i. Species
    ii. Application area
    iii. Maintenance
    iv. Capital and operating costs

5. Proposed strategy, costs and benefits

References:

Kelly, Walton R., Samuel V. Panno and Keith C. Hackley. 2012. The Sources, Distribution and Trends of Chloride in Waters of Illinois " Illinois State Water Survey. *Bulletin B-74*.

Mullaney, John R, David L. Lorenz and Alan D. Arnston. 2009, Chloride in Groundwater and Surface Water in Areas Underlain by the Glacial Aquifer System, Northern United States. United States Geological Survey. *Scientific Investigations Report*. 2009-5086 41 p.

Southeastern Wisconsin Regional Planning Commission. March 2016. A chloride Impact study for Southeastern Wisconsin Region. Southeastern Wisconsin Regional Planning Commission. *Prospectus for a chloride impact study for the southeastern Wisconsin region.*