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Striking a balance between concerns for the environment and safer roads: Smarter salt spreading technologies offer viable solution

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Our nation's increasingly harsh winters demand an effective and affordable means of de-icing roadways in order to help us get around safely. To date, the most viable solution continues to be sodium chloride (road salt) which is composed of 40 percent sodium ions and 60 percent chloride ions.

The problem is that these chemicals make their way into the environment through runoff from rain, melting snow and ice, as well as through splash and spray caused by vehicles and the wind. In recent years, as much as 22 million tons of salt have been spread on US roads (according to Smithsonian.com), which is equivalent to 137 pounds of salt for every American. That's a lot of salt that can find its way onto vegetation and into the soil, groundwater, storm drains and surface waters causing significant impact to the environment.

Of the two chemicals, chloride raises the most concerns because it is completely soluble and very mobile. It is toxic to aquatic life and impacts soil conditions, vegetation, groundwater, surface water, air quality and wildlife. Chloride is not biodegradable. Furthermore, there is no natural process by which chlorides are broken down, metabolized, taken up or removed from the environment.

Numerous studies in various snow-prone states confirm that chloride levels continue to rise with the increased use of road salt. According to the U.S. Geological Survey, domestic salt production quadrupled from 1940 to 1970 largely because of the greater adoption of road salt deicing practices. And the use of road salt continues to climb exponentially. Between 1941 and 1942 only 5,000 tons of salt were spread on the nation's highways. Today, many estimates put national road salt usage above 20 million tons with the largest amounts spread in the Northeast and parts of the Midwest. In 2015, Boston alone applied 113,000 tons of salt through the winter months, the equivalent of 20,600 average-sized elephants.

From 1940 to 2018, the amount of road salt used climbed exponentially.

Impact on water sources

When chlorides from road salt run off and find their way into lakes, rivers and groundwater sources, they can cause irrevocable harm.

Salt-containing water has a higher density than non-salt-containing water and will sink to the bottom of the water body. According to the New Hampshire Department of Environmental Science, this can result in chemical stratification and disrupt the lake mixing patterns. This, in turn, prevents the dissolved oxygen within the upper layers of the water from reaching the bottom layers and nutrients within the bottom layers from reaching the top layers. The result is that the bottom layer of the water body becomes void of oxygen and is unable to support aquatic life. Small ponds and slow streams are most impacted because the likelihood of dilution and dispersion is lower.

Chloride concentrations above 800 ppm are harmful to most freshwater aquatic organisms because these high levels interfere with how animals regulate the uptake of salt into their bodies. A range of studies have found that chloride from road salt can negatively impact the survival rates of crustaceans, amphibians such as salamanders and frogs, fish, plants and other organisms.

How widespread is the problem?

According to an article on smithsonianmag.com, an estimated 40 percent of the country's urban streams have chloride levels that exceed safe guidelines for aquatic life, largely because of road salt. In 2014 already, the US Geological Survey (USGS) found that chloride levels were on the rise in 84% of the urban streams studied with 29% exceeding federal safety limits of 230 milligrams per liter for at least part of the year.

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At a more localized level, the small state of New Hampshire had listed 19 water bodies impaired by chloride in 2008. By 2010, that number increased to 40. Long-term studies of watersheds conducted in New York show that concentrations of sodium and chloride increased 130% and 243% respectively, over a 45-year period, with road salting the primary reason. A stream in southeastern New York was monitored over a 19-year period and was found to experience a similar pattern, with significant annual increases and road salting to blame for an estimated 91% of sodium chloride in the watershed.

Impact on soil

Salt runs off roadways creating the greatest concentrations of chloride within 2-3 meters from the road edge, although some studies have shown salt to be found as far out as 10 meters from the road edge. The distance that salt travels through the soil depends on subsurface conditions.

Long-term accumulation of chloride can influence the chemistry of the soil. Through ion exchange, the salt stays within the soil and releases other ions such as calcium, magnesium and potassium. According to the National Research Council, this causes depletion in the soil and changes the soil permeability which makes it more difficult for the soil to retain water and contribute to plant growth and erosion control. It also affects the chemical properties of the soil, increasing soil alkalinity and density.

The National Research Council additionally warns that roadside vegetation can be negatively impacted by the absorption of chloride through the plant roots or by accumulating on the foliage and branches. Signs of damage are similar to those brought about by a drought and include stunted growth, brown and falling leaves/needles and dying limbs. The effect of chloride on plants has been seen at distances of 100 to 650 feet off the road. The level of chloride that must be reached before the plant is harmed depends on the type of vegetation.

Impact on wildlife

Particularly high concentrations of sodium and chloride can be found in snow melt, which many animals drink. This can cause salt toxicity, including dehydration, confusion and weakness, among other symptoms. Damage to vegetation can also significantly impact wildlife habitat by destroying food resources, shelter and breeding and nesting sites.

Road salt affects the health of wildlife, including birds and mammals, in other ways, as well. Birds, which are especially sensitive to salt, often mistake road salt crystals for seeds or grit. Consumption of very small amounts of salt can result in toxicosis and death within the bird population. Wildlife such as deer and moose are attracted to the roadways to ingest salt crystals, which leads to higher incidents of vehicular accidents and wildlife kills.

Impact on infrastructure

The devastating effects of salt buildup even take their toll on our country's roads and bridges. That's because salt is corrosive. According to a local government site in New Hampshire, chloride can penetrate and deteriorate concrete on bridge decking and parking garage structures and damage reinforcing rods, compromising structural integrity.

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Environmental impact attracts more attention and outrage

The growing environmental problems caused by too much road salt have not escaped the attention of various government entities or taxpayers. In 2004, the Canadian government categorized road salt as a toxin and placed new guidelines on its use. The non-profit organization Smart About Salt Council was also formed in Canada to provide education around innovative approaches to limiting road salt usage in winter maintenance programs.

The problem has also prompted action here in the US. In 2013 the US Department of Transportation established the Center for Environmentally Sustainable Transportation in Cold Climates. Among other initiatives, the Center has been working on research that evaluates newer smart snow removal equipment that measures pavement temp and detects residual salt.

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The US Conference of Mayors also continues to hail the environment as a priority. It was in 2005 that the organization launched its Mayors Climate Protection Agreement which garnered more than 1,000 signatures. At the annual meeting in 2017, the organization again approved resolutions focused on the environment. In that same year, the National League of Cities additionally vowed to preserve environmental goals.

More recently, in January 2018, a peer-reviewed study was published in the Proceedings of the National Academy of Sciences. Based on five decades of data from 232 US Geological Survey river and stream monitoring sites, it was the first study to assess the extended changes in freshwater salinity and alkalinity across the continent, finding significant increases in both. Specifically, salinity was found to be higher in 37% of the drainage areas of the contiguous US, while alkalinity was up in 90% of the studied areas.

The biggest changes were documented in rivers in areas with more pronounced snowfall. Although the study confirmed that road salt was not the only cause, it was listed as a primary contributor to the problem.

Environmental groups continue to lead the call for change, putting pressure on local municipalities and state DOTs. As a result, high-visibility articles regarding the problem of too much salt on our roads have appeared in such leading national magazines and newspapers as *The Washington Post, Popular Science, Business Insider* and *The Guardian.* National online sources, including accuweather.com and weather.com, have also featured news reports about the environmental impact of too much salt on our roads. On a more local targeted level, newspaper articles warning of environmental dangers have appeared in cities as diverse as Chicago, Pittsburgh, Milwaukee, New York and even as far away as Savannah and Ontario, Canada.

How can we preserve the environment and still keep our roads safe?

It seems as though the goal of minimizing soil and water contamination conflicts with our need to create safer driving conditions. We know we need salt on our roads. Despite efforts to explore de-icing alternatives, sodium chloride (road salt) remains the most viable from a cost and effectiveness perspective.

That leaves us with one simple solution: smarter salt spreading.

The technology already exists to significantly reduce salt usage while actually improving the safety of roadways.

Many European countries with significant snowfall, in fact, have been proving the feasibility of smart salt spreading technologies for decades.

In the US, the adoption of smart salt spreading processes has been a bit slower, although significant progress has been made in recent years, largely as a result of ongoing salt shortages and increasing salt prices. Many DOTs and municipalities already use what is known as a pre-wet ratio in which salt and liquid are mixed to improve efficiency. The average pre-wet ratio used in the US today is about 95:5 (5% brine).

That's good—certainly better than using dry salt which is more likely to bounce or scatter off the road—but it's not good enough.

In Europe, where many snow-prone countries are leading the effort to adopt technologies that minimize environmental impact, they have found that a pre-wet ratio of 70:30 (30% brine) yields superior results. These results were presented early in 2018 at the International Winter Road Congress. According to the data presented, the super-saturated mixture does a better job of melting ice while using 30% less salt. That's less salt to run off the sides of the road and harm soil and water quality, not to mention the obvious cost savings.

American technology and know-how are well-respected in many industries. In the area of winter road maintenance, however, it appears that there are valuable lessons that can be learned by looking across the ocean to our European counterparts where higher standards for safety and environmental impact are being met year-after-year.

For more information on how to optimize salt usage to help improve the environment while keeping our roads safe, visit **SpreadSaltSmarter.com**

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