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THE EFFECTS OF WINTER ROAD SALT RUN-OFF ON RIVER SYSTEMS: A REVIEW OF POTENTIAL ALTERNATIVES AND REMEDIATION STRATEGIES

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Alex Robinson* and Lindsey Thomson**
*Research Shop Intern
**CESI Community Engaged Learning Manager

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University of Guelph
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COMMUNITY ENGAGED SCHOLARSHIP INSTITUTE
College of Social and Applied Human Sciences
University of Guelph Guelph, Ontario Canada N1G 2W1
519 / 824.4120 Ext. 53829 | cesi@uoguelph.ca
www.theresearchshop.ca

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INTRODUCTION

During the winter months, in areas with snowfall and freezing temperatures, road salt is utilized. Road salt lowers the freezing point for the prevention of snow or ice adhesion on roads which allows for removal of the ice and snow by snowplough (USEPA, 2010). However, there are many issues around road salt and its use. Road salt builds up easily and does not breakdown or disperse (Wagner, 2001). This leads to contamination and damaging issues in water systems, such as lakes and rivers, since roadway run-off typically contains a large amount of road salt when the spring melt occurs (Novotny & Stefan, 2010). Wellington County is quite proactive in their mitigation of road salt run-off and accumulation in local water systems but the County has the potential to utilize additional solutions, such as community projects and alternatives to road salt (Wellington County, 2012). With the County and the City of Guelph characteristically being quite motivated when it comes to environmental management and sustainability in the community, identifying these possible areas of development when it comes to winter road salt run-off alleviation, Wellington County can continue to be proactive in their approaches to environmental sustainability.

Wellington Water Watchers is a non-profit, primarily volunteer-run organization that was established in 2007 to protect the local Guelph-Wellington watershed and educate the public on water, its importance to the environment and the community, and the threats to its quality and quantity. This review aims to determine the impact of winter salt road run-off on the rivers as well as possible remediation methods. This will include discovering alternatives to salt, community-engaged activities, or best management practices utilized in other communities that could be brought to Wellington County. This information will be used by the Wellington Water Watchers to inform the community about methods of addressing the effects of road salt within Wellington County, with the possibility of hosting a related activity as part of the 2015 2Rivers Cleanup in June.

WINTER ROAD SALT EFFECTS

Road salt, or sodium chloride, has very negative effects on the natural environment. Nevertheless, it is still the most commonly utilized de-icer because it is so plentiful, easily accessible, and inexpensive (Fay & Shi, 2012). It impacts the vegetation; allowing invasions of species that can handle high salinity, decreasing their growth, as well as causing root injuries (RiverSides, 2006). Over half of woody plant species are sensitive to sodium chloride (RiverSides, 2006). It impacts the wildlife; increases roadside

vehicular deaths given wildlife's attraction to the roadside salt pools, causes dehydration, as well as loss of food and shelter due to the vegetation decline (RiverSides, 2006). It impacts the soil; causing weakening of the soil structure leading to soil stability weakening, as well as soil permeability decline (RiverSides, 2006). It impacts the surface water; sodium chloride is toxic to most fish species, prevents mixing of the oxygen water levels leading to a decrease in the amount of available oxygen, as well as freeing possibly dangerous heavy metals from the sediment (RiverSides, 2006). It impacts groundwater; creating high saline water that then negatively impacts the available drinking water that flows to the surface water supply (RiverSides, 2006).

Not only is the environment affected by road salts, but so is our infrastructure. Build-up by stormwater management facilities can greatly alter filtration and cause accumulation in the groundwater aquifers, resulting in many issues down the line and even creating an increase in sodium chloride in our tap water (Marsalek & Schreier, 2009). Sodium chloride can also cause great damage with corrosion and rusting of concrete structures, steel bridges, and metal on vehicles (Shi, Fay, Yang, Nguyen & Liu, 2009).

Road salt can get into water systems without difficulty due to its high solubility and once the salts reach one part of a flowing system, they can quite easily impact a great number of regions (Fay & Shi, 2012). With road safety still in mind, a reduction or replacement of road salts in the winter months is advisable in order to mitigate these negative effects before permanent damage is caused not only to the environment but also to our vehicles and infrastructure.

ROAD SALT ALTERNATIVES AND COMMUNITY INVOLVEMENT

Canada, as a whole, uses 5 million tons of road salt on their roadways annually (Wagner, 2001). Finding alternatives to salt usage would be ideal in the alleviation of sodium chloride damage.

Wellington County is quite proactive in reducing their road salt usage (Wellington County, 2012). The County utilizes a pre-storm application process of liquid de-icer (a mixture of refined corn, magnesium chloride and water) to not only reduce the freezing point of the road to decrease snow and ice adhesion before a winter storm occurs, but also to assist in the bond of road salts to the road surface (Wellington County, 2012). Both of these outcomes reduce the amount of road salt usage required. This liquid de-icer is a great deal safer for the environment and infrastructure and it even meets Canadian Drinking Water Standards (Wellington County, 2012). Wellington County was

in fact the first to utilize this type of pre-wetting process. The County created a Code of Practice for this management practice, which was published by Environment Canada and is now used as a guide for winter road management all over Canada (Environment Canada, 2012).

Possible current and common alternatives to road salt include; sand, calcium chloride, magnesium chloride, calcium magnesium acetate, and other mixtures of chlorides and organic compounds (USEPA, 2010). However, none of these alternatives are vastly better for the environment and most are generally more expensive than sodium chloride (USEPA, 2010). However, in some regions, certain types are applied in particular areas. For example, in New England, calcium chloride is utilized in areas where the source water already contains high sodium concentrations so as to not increase these concentrations unnecessarily (USEPA, 2010). This is a good method, although it would take a fair amount of effort and research into the local waterway composition before it could be put into action.

Another alternative that is gaining awareness is beet juice derivatives. This is an organic by-product of the refining process of sugar beet juice. It is applied to roads before a winter storm, as with a liquid de-icer, mixed with a salt brine (Niagara Region, 2011). This allows for even less salt to be utilized and for application to occur jointly instead of an initial application of liquid de-icer, followed by an application of road salt. It is also biodegradable and completely harmless to roadside vegetation, unlike the liquid de-icer which is safer than pure road salt but still contains magnesium chloride (USEPA, 2010). This alternative practice was first attempted in Niagara and the results are quite positive (Niagara Region, 2011).

Phytoremediation is use of plants in the removal of environmental pollutants (Salt, Smith, & Raskin, 1998). However, there is a lack of literature on the use of this technique for road salt or sodium chloride removal. Recently, research was run on the optimal nutrient supply and residence time of two species of wetland vegetation, Atriplex patula and Typha angustifolia (Morteau, Triffault-Bouchet, Galvez, & Martel, 2015). This is the first step in determining if phytoremediation or phytoabsportion is possible for road salt run-off. The researchers stated that this method seems possible, however additional research with an actual trial, now that the optimal nutrient supply and residence time are determined, needs to occur (Morteau, Triffault-Bouchet, Galvez, & Martel, 2015). Therefore, this method may be possible in the future, but currently its suitability for salt remediation is unknown.

Unfortunately, there were no specific road salt run-off community projects that were observed in other communities, however there are ways to make a neighbourhood more of a permeable environment, which reduces the speed of run-off. Community projects or workshops that can be completed to increase this permeability include; creation of community rain gardens (planting of native species on top of specific layers of gravel and soil near storm drains), construction and/or distribution of rain barrels, depavement where possible (paved areas are highly susceptible to fast run-off into waterways), and planting of trees by roadways (In Our Backyard, Inc., 2014). Another great tool is education. Educating the public on winter road salt usage would be a great asset in the mitigation of overuse in households. If the majority of residents of a community are utilizing road salt in the correct locations, at the correct times, and not overusing it in any way, this will be an excellent outlet for the reduction of road salt damage (Fay & Shi, 2012).

There are many suggested “best solutions” indicated in the literature, these include:

- Alternative de-icers (Novotny & Stefan, 2010)
- Applying particular de-icers in certain areas depending on the chemistry of the water in each area (Novotny & Stefan, 2010)
- Diversion of snowmelt (Novotny & Stefan, 2010)
- Reduction in usage (Corsi, Graczyk, Geis, Booth & Richards, 2010)
- Pre-wetting strategies (Delcan, 2003)
- Social change towards an increase in winter tire usage (RiverSides, 2006)
- Increased road weather monitoring to combat road maintenance requirements (USEPA, 2010)

However, there does not seem to be one overarching solution to the damaging effects of winter road salt. It seems as if a reduction in road salts should be a priority, but an elimination of salt in some form to contend with the dangerous ice formation on roadways is not. Wellington County is doing a fair amount when it comes to this mitigation, however there are some management practices, such as community involvement in overall neighbourhood environmental sustainability or applications practices, such as beet juice derivative treatment, that are perhaps suitable for use in Wellington County and may be worth considering in the future.

CONCLUSIONS AND RECOMMENDATIONS

Although there is not one particular solution that can greatly reduce the amount of winter road salt run-off, there are methods that can help a community move towards this primary goal. Setting overall best management practices may be one effective strategy. For example, in-depth training and education not only for winter maintenance staff but also for general community members regarding proper winter de-icing protocols. Engaging the community in any way, such as creating a more permeable city environment will not only help with mitigation of sodium chloride but will also get community members involved and informed on the damage it can cause, ideally leading to future actions towards positive change. Where possible, remedial measures to restore damaged roadsides areas, including soil and vegetation, should be taken (Fay & Shi, 2012). With identification of sensitive areas and sensitive vegetation and animal species, better management can be established and specific practices around salt usage can be implemented based on the area (Fay & Shi, 2012). Increasing knowledge of and including practices such as beet juice derivative and salt brine application could be a great tool for a community like Wellington County. Another great asset would be more research into this area of study. It seems as if this is slowly becoming an area of interest for the scientific community and if this trend continues, there should be a great deal of communication between the scientific community, the City Council, and the general public to ensure that up-and-coming methods are being utilized sooner rather than later. Although winter road salt run-off is dangerous and accumulating in our communities, it seems as if it is already understood as having negative impacts and is starting to be remedied slowly but surely, but with help we hope to continue this upswing and implement improvements before too long.

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