CLEAR ROADS
research for winter highway maintenance

RESEARCH BRIEF

JUNE 2024

IDENTIFYING ROADWAY SEGMENTS SENSITIVE TO CHLORIDE DEICERS

RESULTS SUMMARY

A new software tool may help agencies identify roadside environments that are most sensitive to chloride deicers, which could mitigate the impacts of winter road clearing activities on sensitive environmental receptors and drinking water.

PROJECT DETAILS

Project Title: Using GIS to Highlight Highway Segments Sensitive to Deicing Material

Project Number: CR20-05

Project Cost: $155,002

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Project Co-Champions:
Joe Thompson
New York State Department of Transportation
joe.thompson@dot.ny.gov

Mark Goldstein
Massachusetts Department of Transportation
mark.a.goldstein@state.ma.us

Investigator: Mark Gallagher
SRF Consulting Group, Inc.
mgallagher@srfconsulting.com

Need for Research

Winter road crews depend on deicers with sodium chloride, magnesium chloride and calcium chloride to keep roads clear. However, using these products has environmental consequences. Chlorides degrade soils and cause harmful impacts to vegetation. In streams, lakes and underground aquifers, chlorides can cause unhealthy algal blooms, which adversely affect fish reproduction and drinking water quality.

The sensitivity of roadside environments to chlorides depends on factors such as soil type, drainage, nearby waterways and land use. When choosing deicing products, winter maintenance managers must consider minimizing human exposure and protecting environmental resources in addition to public safety and fiscal reasons to reduce salt use.

While there are few viable alternatives to chloride deicers, other chloride reduction strategies may include adjusting application rates, using specially treated chloride mixtures and implementing alternative strategies such as brine preapplication. To target mitigation efforts and cost-effectively balance mobility and resource protection, Clear Roads agencies sought to understand which roadway areas have natural resources most vulnerable to chloride use.

Objectives and Methodology

The goal of this project was to create a geographic information system (GIS) based tool to help winter maintenance managers identify sensitive roadway environments. A review of existing literature illustrated the impacts of chloride deicing chemicals on the flora, fauna and water systems near roadways and pointed to factors to consider in a geospatial model. A survey of state transportation agencies explored current practices and tools that winter crews use to reduce salt use and mitigate adverse impacts from deicers. The survey also collected chloride use data and impact assessment methods.

Investigators identified and analyzed potential data sources that could provide model inputs to the tool. Nineteen possible data sets included descriptions of

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A GIS-based computer model could help state DOTs target chloride reduction efforts and mitigate environmental impacts. (Photo courtesy of New York State DOT)

roadway characteristics and biological qualities such as land cover, habitat and other ecological data. Other sources illustrated geologic properties; soil types; and water resources such as hydrology, well locations and special water designations.

Experts in water quality and other resources assisted in ranking the potential data sets based on completeness, accuracy and accessibility across states; their ability to sufficiently inform the model outputs; and geographical representativeness. Investigators developed a geospatial software tool using ArcGIS Pro to map sensitive roadway environments. Beta-testing by project committee members identified necessary revisions.

Results

The model, when run with suitable software and computing capacity, successfully processed numerous variables and calculated a relative sensitivity value for roadside environments. The new software tool required significant computer processing and storage resources. Specific software dependencies, including Microsoft Windows version 10 or later and ArcGIS Pro workstation version 2.9.2 with Spatial Analyst, were also identified.

The model relied on minimum data sets:

- Agency plow route network of interest.
- U.S. Fish and Wildlife Service's National Wetlands Inventory containing the location and type of wetlands and the National Hydrography Dataset of streams and rivers.
- U.S. Department of Agriculture's Natural Resources Conservation Service Soil Survey Geographic Database, which describes soil and drainage conditions to understand how chemicals may move off the roadway.
- National Land Cover Dataset, including sensitive areas such as agriculture.

Other data sets that support protecting resources such as waterways in the National Wild and Scenic Rivers System, wellhead protection areas, chloride-impaired streams and critical species habitat could be incorporated depending on unique sensitivities of the state or area and the resource of interest.

Testing of the tool revealed installation difficulties and a steep learning curve, which resulted in some usability issues. Barriers included agency firewall policies, network or server issues, computer storage, limiting access to needed data sets and incompatible software versions. In response, investigators developed a "pre-install" tool to support software installation and retrieval of necessary data. Finally, to accompany the tool, a user guide and video described installation steps and instructions for use.

Benefits and Further Research

The GIS model could be a powerful, flexible tool to support state departments of transportation (DOTs) in targeting efforts to reduce chloride use and mitigate environmental impacts. State natural resource agencies could also benefit from the tool.

While the current model identifies relative chloride sensitivity of natural resources along roadsides, additional research could explore calibrating model outputs to environmental impacts and identifying mitigation options. Clear Roads may consider developing an online tool to address the usability and data access issues.

"This GIS tool provides a targeted and efficient approach to reduce chloride use, advance our environmental stewardship efforts and protect drinking water quality."

Project Co-Champion Joe Thompson
New York State DOT
joe.thompson@dot.ny.gov

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