

RESEARCH BRIEF

Investigator



“Compared with current winter severity indexes, this research provides a more reliable basis for isolating the impacts of varying weather conditions on the underlying costs and effectiveness of winter maintenance.”

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Mapping Winter Weather Severity Zones

State departments of transportation are under constant pressure to justify expenditures for snowplowing, deicing and other winter maintenance activities. To effectively defend current budgets and requests for additional funds, winter maintenance professionals need solid data on expenditures, winter severity and achievable levels of service, not only within their own states but regionally and nationally. They also need to show how increased efficiency can reduce costs while maintaining the required level of service.

However, transportation agencies face several challenges in measuring the various aspects of winter maintenance operations. Performance measurement requires programs and tools that cost money to develop and apply, and the outcomes of maintenance activities can be difficult to quantify. In addition, variability in winter weather severity and in levels of service—from year to year and from place to place—makes objective comparisons challenging.

Need for Research

To assess the efficiency of winter maintenance operations over time, agencies typically look at expenditures as a function of winter severity, using a tool often called a winter severity index. These indexes give statistical weight to standard components of winter weather—such as frequency of snowfall events, depth of snowfall, and duration of freezing rain events—and combine them to create a single severity value for a given time period.

Quantifying severity in a consistent way allows agencies to make more objective comparisons of winter maintenance expenditures from one year to the next. For example, an agency that keeps its winter maintenance expenditures the same even as the winter severity index increases is showing efficiency gains. However, different states calculate their winter severity indexes differently, so it is difficult to compare performance across agencies or to identify the most efficient practices among snowy states.

To help meet these performance measurement challenges, Clear Roads is sponsoring the “True Costs of Winter Maintenance” project, a multiphase effort aimed at developing a tool to determine the true costs of snow and ice removal in the context of varying winter conditions from state to state and year to year. The first step in this project is to develop a standard methodology for quantifying and mapping the severity of winter weather across the United States, allowing for a more meaningful comparison of costs across different geographic areas.

Objectives and Methodology

This project’s goal was to develop a method for mapping winter weather severity across the country, ultimately producing maps that present a visual picture of winter severity zones similar to the plant hardiness zone maps used for agriculture.

Researchers began by compiling meteorological data from the National Weather Service and Federal Aviation Administration from 2000 to 2010. Because this data did not include reliable snowfall data, researchers used algorithms to derive hour-by-hour estimates of historical snowfall rates and the occurrence of blowing and drifting snow, including the snow’s depth and propensity to blow in the presence of varying wind speeds.

Researchers then selected standard parameters considered to be indicators of weather severity. Through an iterative process of data compilation and analysis, and by assessing the parameters’ usefulness based on their effects on winter maintenance costs, they selected the following indicators:

- Average annual snowfall accumulation
- Average annual duration of snowfall

Project Champion

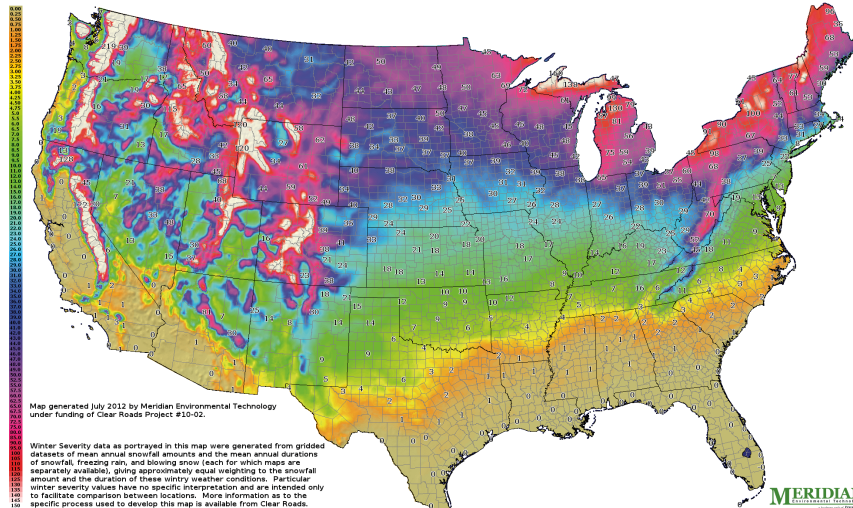


“Comparing winter maintenance costs among different agencies requires that we identify regions with similar weather patterns and similar levels of service.”

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U.S. Winter Severity for Winter Road Maintenance

CLEAR ROADS
SEARCH FOR WINTER-DRIFTING SNOW



Researchers developed color-coded maps showing average annual snowfall amount, snowfall duration, freezing rain duration and blowing/drifted snow duration. This composite map illustrates overall winter weather severity across the country using an index that combines all of these parameters.

- Average annual duration of freezing rain
- Average annual duration of blowing/drifted snow
- A combined measure of overall winter severity based on these parameters

Researchers aggregated and processed weather information for these indicators for geographical zones that consisted of 0.25° latitude x 0.25° longitude blocks. To account for biases they discovered in weather sensors, they used weather analysis and forecasting model data to provide a baseline that could be adjusted to loosely fit the available observations. These models provided a better representation of where and when weather conditions vary. Finally, researchers used a variety of approaches and datasets to calculate each winter severity measure for geographical zones across the United States.

Results

Researchers created high-resolution maps and datasets for the individual winter severity parameters across the United States. They also created a composite map illustrating overall winter severity via an index that combines the individual winter severity parameters. Data formats include gridded datasets, which map weather data onto a two-dimensional grid; shapefiles, for use in geographic information systems software; and comma-separated values files, which will facilitate the use of winter severity data in the second phase of Clear Roads' "True Costs of Winter Maintenance" project. Researchers also developed software to convert gridded data into shapefiles to facilitate the visualization of data from this project alongside other datasets using GIS software.

Benefits and Further Research

The maps and data generated through this project provide a standard framework for comparing winter weather severity across the United States. This allows agencies to make cost comparisons with states that have similar climates and consider new budget scenarios based on the successes of other agencies—ultimately improving the effectiveness and efficiency of their winter maintenance operations.

Possible future research directions include creating winter weather severity maps on an annual basis; the maps created for this project represent an average of historical data.

Brief prepared by
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