

Executive Summary, Research Readiness Level Assessment, and Technology Transfer

Development of the Nebraska Department of Transportation Winter Severity Index – Phase I and Phase II

Research Benefits

- Develop a winter severity index that can be used to normalize the performance of winter maintenance operations.
- Develop a predictive winter severity metric.
- Enhance existing internal stakeholder coordination efforts such as providing additional guidance on when to initiate planning for an event.
- Use the upgraded spatial and temporal resolution and forecast ability of NEWINS to promote improved resource allocations.
- Results of the proposed research may facilitate winter severity inclusion into NDOT's MDSS.

Phase I Objectives

The study aims to develop a winter severity index to standardize the performance of winter maintenance operations. The study will result in a statewide winter severity index for the state of Nebraska (NeWinS) that can be used as a reference to measure how well NDOR operations and maintenance procedures return the roads to normal driving conditions after winter weather events; driving conditions will be considered normal when speeds return to 65 mph on the interstate highway system. NeWinS will be a statistical model developed from meteorological data—precipitation, temperature, moisture, and atmospheric conditions—from events occurring over the past ten years.

Principal Investigator

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Background

Nebraska does not currently have a winter index to accurately measure its winter maintenance operations' performance. Several studies have been conducted in other states to develop such winter-severity and performance indices. Many agencies incorporate speed and volume indices as stand-ins for mobility in their performance-measurement process. Concurrently, to determine an agency's level of performance in mitigating the impact of a winter storm on highway mobility, the storm's severity must be quantified to normalize performance based on the severity of the storm. This winter severity index can be used to measure the degree of difficulty storms create in maintaining the targeted mobility. Before Nebraska can invest in a performance metric for winter maintenance, the state must develop an accurate winter index. To increase the efficiency of this research, the proposed work will analyze the winter indexing procedures of other states. By building this proposed work on the methodologies of previous studies, this research will hone the procedures to enhance efficiency and efficacy. The development of a Nebraska winter weather severity index will use the results from these types of studies to identify the parameters that should go into the index.

Phase I Conclusion

A ten-year (2006-2016) winter season database of meteorological variables for Nebraska was obtained from the National Centers for Environmental Information. Meteorological parameters were grouped into categories that subsequently provided a storm classification database. The NEWINS is based on a weighted linear combination to the collected database to measure severity statewide and across NDOT individual districts. The NEWINS results were compared to other meteorological variables, many used in other agencies' winter severity indices. This comparison verified the NEWINS robustness for the observed events for the ten-year period. For example, an assessment of the difference between days with observed snowfall versus days with accumulated snowfall revealed a 39% average reduction in days. Furthermore, the NEWINS results highlight the greater number of events during the 2009-2010 winter season, and the lack of events during the 2011-2012 drought year. The NEWINS also shows strong differences monthly and among NDOT districts across the state with a general decrease in events from the western to eastern NDOT districts. In addition, NEWINS storm classifications were compared to NDOT winter maintenance operations performance data for a sample winter season. Last, the 2016-17 winter season was computed to provide a testbed for the NEWINS procedure. It is expected that the NEWINS could help transportation personnel to efficiently allocate resources during adverse weather events, while balancing safety, mobility, and available budget. Further, the theoretical and practical contributions provided by the NEWINS can be used by other agencies to assess their weather sensitivity.

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Phase I NDOT Recommendations Based Off Research Project – 2020 – RRL3

This research provides the NDOT with the Nebraska Winter Severity Index (NEWINS), providing an independent, historic meteorological baseline of individual winter storm severity and overall-statewide winter seasonal severity. The Department can use this information to justify annual winter maintenance budget expenses and allocations. Further research will be done to assess the NEWINS in the context of the Maintenance Decision Support System (MDSS) and with respect to weather-related vehicular crash severity.

This research was proposed as Phase I of a two phase project. The proposed Phase II NEWINS work builds on this previous implementation by allowing NDOT to consider winter storms from a forward-looking, personnel scheduling and planning perspective. These prior insights remain relevant for future work. In the case Phase II of this project receives funding, Phase II hopes to provide NDOT with further information to support its winter maintenance operations activities and objectives by forecasting quantified winter storm impacts and integrating a multi-hazards prediction framework for winter weather events.

- As provided by Mark Anderson, Principal Investigator

Phase II Objectives

The study objectives are to expand and evaluate the NEWINS tool. This expansion intends to refine the spatial and temporal resolution of the enhanced NEWINS at the supervisor and superintendent level of a NDOT district. Additionally, the enhanced index will be evaluated to include freezing rain and icing events. Further consideration of post-event weather conditions such as blowing and drifting snow and sub-freezing temperatures could also be included into NEWINS. Last, NEWINS will incorporate computer model forecast data instead of climatological data, which has been done in the past. This allows NEWINS data to be evaluated up to 72 hours before, or during an event. The forecasted NEWINS weather information will allow for maintenance planning and scheduling based on forecasted impacts.

Phase II Conclusion

For the Nebraska Department of Transportation (NDOT), the Nebraska Winter Severity Index (NEWINS) provided an independent framework to calculate a winter season's severity by categorizing individual winter storms. However, one of the greatest limitations of NEWINS is that it is not predictive. Thus, this study builds on the previously developed NEWINS by creating a predictive winter storm severity index known as NEWINS-Predictive (NEWINS-P). The quantitative precipitation forecast, snow accumulation, ice accumulation, and surface wind speed parameters from the National Digital Forecast Database (NDFD) are used to develop the five components composing the NEWINS-P framework. These components consist of snow severity (NEWINS-S), precipitation type, ice likelihood, blowing snow, and drifting snow likelihood, and attempt to forecast different in-storm and post-storm winter weather hazards over a 72 hour duration at a 6-h resolution. The NEWINS-P framework is assessed through spatial forecasts across Nebraska and temporal forecasts at Nebraska airports on select Colorado Low and Alberta Clipper Systems from the 2018-19, 2021-22, and 2022-23 winter seasons. Additionally, spatial and temporal forecast trends are investigated in each system for select components to assess their degree of change. The results show that Colorado Low Systems were forecasted to have a larger areal extent and longevity of winter weather hazards than Alberta Clipper Systems. Furthermore, the Colorado Low Systems produce a higher intensity and spatial coverage of NEWINS-S, more types of precipitation, more icing concerns, and more blowing snow concerns. Post-storm impacts such as drifting snow are not forecasted in most systems as surface wind speeds decrease rapidly following the conclusion of snow accumulation. In all systems analyzed, the forecast trends reveal an increasing intensity of NEWINS-S as the system gets closer in time. Interpretations of the NEWINS-P output can be affected by a systematic artifact within the NDFD that is caused by forecast differences between weather forecast offices. In summary, NEWINS-P is a tool that supports NDOT in its winter maintenance operations for personnel and resource planning in advance of winter storms.

Interested in finding out more?

Phase I Final Report Available:

[HERE](#)

Phase II Final Report Available:

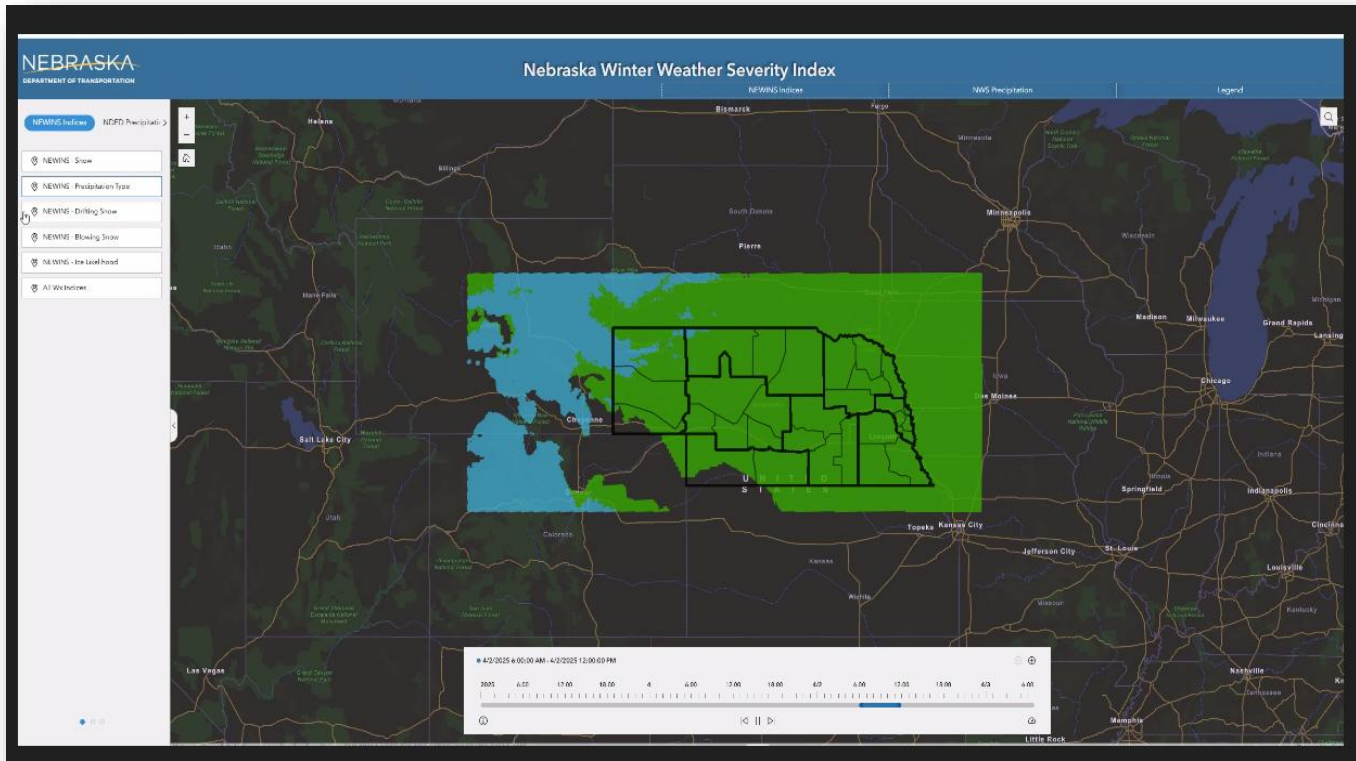
[HERE](#)

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Phase II NDOT Recommendations Based Off of Research Project – 2025 – RRL4

This research allowed the NDOT to update their Nebraska Winter Severity Index (NEWINS) to have predictive capabilities and include four more categories by which to view data. The NEWINS index facilitate a framework to categorize winter severity specifically in Nebraska, providing greater resolution and placing an emphasis road infrastructure for the state instead of climatological data, which has been done in the past. The research team provided code which the Department modified to rewrite and update the NEWINS developed in phase I. This was partly done to create more progressive resolution, showing 6-hour blocks of weather. The four additional categories provided in the research were precipitation type, ice accumulation, blowing snow, and drifting snow, which were modified by the Department to be spatially placed in the NEWINS.

The Department has two versions of the NEWINS map in testing and nearly ready to be put into production, with the two versions differing based on one having a column and one having a timeline to show results at different times. The Department still needs to determine which of these two versions to move forward with. The finalized NEWINS will be available to streamline road conditions as reported on Nebraska's 511 traveler information portal or with regards to whether a storm will trigger a Pathfinder coordination teleconference among NDOT and its partner agencies. With the completion NEWINS the Department hopes to support its winter maintenance operations activities to forecast and quantify winter storm impacts by integrate/predict winter weather events. Figure shown below is the NEWINS.



- As provided by Tom Renninger and Claire Inbody, Implementation Team

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Research Readiness Level (RRL) Assessment

RRL 4

Level 4: Implementation with follow up.

This implementation will be in production for couple of years to refine if necessary. Moved up from RRL3 (Phase I), assessed 2020.

Technology Transfers

Phase I:

Principal Investigator did not have any technology transfer for this research project.

Phase II:

Webinars/Presentations

- Expanding the Nebraska Winter Severity Index, Thomas Sander Kauzlarich, Mark R. Anderson, Curtis L. Walker, and Liang Chen, 23rd Annual Student Conference, 104th Annual American Meteorological Society, Baltimore, Maryland.
- Expansion of the Nebraska Winter Severity Index, Thomas Sander Kauzlarich, Mark R. Anderson, Curtis L. Walker, and Liang Chen, 12th Symposium on the Weather, Water, and Climate Enterprise, 104th Annual American Meteorological Society, Baltimore, Maryland.

This brief summarizes Project SPR-P1(17) M054 and SPR-FY23(017):

“Development of the Nebraska Department of Transportation Winter Severity Index – Phase I”

“Development of the Nebraska Department of Transportation Winter Severity Index – Phase II”

Nebraska Department of Transportation Research Program