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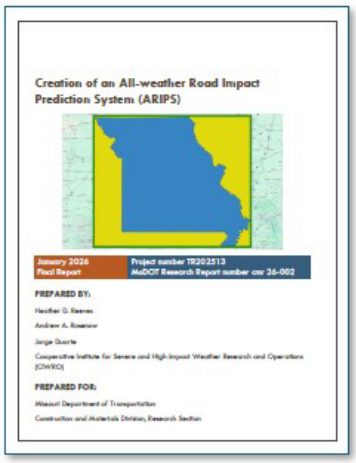
Research Summary

Creation of an All-weather Road Impact Prediction System (ARIPS)



Flash flooding represents a substantial threat to the roadway network. These closures can be difficult to predict, and need to be enacted quickly. The many factors that lead to flash flooding make it well-suited for an Artificial Intelligence/Machine Learning (AI/ML) model.

This project explored whether the database of flooding closures kept by MoDOT could be combined with precipitation datasets being created within the Multi-Radar Multi Sensor (MRMS) operational meteorological system developed at the University of Oklahoma to develop and train an AI/ML model. This model would predict the probability that a given point will experience flash flooding on a road.

An evaluation of MRMS products was conducted. These included quantitative precipitation estimates (QPEs) - instantaneous rate, and accumulated precipitation over hourly, three-hourly, six-hourly, and twenty-four-hourly periods. Hydrologic model products from MRMS quantify the hydrologic response to precipitation. Finally non-meteorological factors, such as ground permeability, land use, terrain slope, elevation, and more were included. These myriad fields enable the AI/ML model to identify factors that exacerbate or limit flooding.

The first task was to assemble the data needed for eventual model training. Due to the massive size of the MRMS grids (24.5 million grid points), a Missouri-encompassing domain was created and applied to all the meteorological data fields to make the database size more manageable and reduce the train time of the AI/ML model. Once assembled, the combined dataflow for model training was interrogated.

"The MoDOT road-closure database provides a one-of-a-kind opportunity to use AI methods to better predict road closures due to flash floods. This research lays the necessary foundation to establish best practices for using this database for cutting edge decision support for MoDOT operations."

The second task was to evaluate the dataset suitability for AI/ML applications (e.g. Fig. 1). A few obstacles revealed by combining these data require further work to be AI/ML ready. The first is that the closures only list the day of the closure, not the hour. As the MRMS data has an hourly cadence, with precipitation rates every two minutes, a more precise flooding time will improve the model. The second is the lack of non-flooding events in the dataset. For a model to learn probabilities, it needs examples of near-events that did not flood in order to differentiate

between the two. Thus, a dataset of rainy, but non-flooding events needs to be created.

These identified issues can both be solved as part of a future research effort. Moreover, the dataset developed here can be used to solve both issues. A method can be developed to estimate the time of flooding from the rainfall and hydrologic model outputs, and a negative events dataset could be developed using those in conjunction with the observed closure locations.

With the dataset created here and future solutions for identified issues, the data assembled here will be ready for training an AI/ML model to predict flash flood closures.

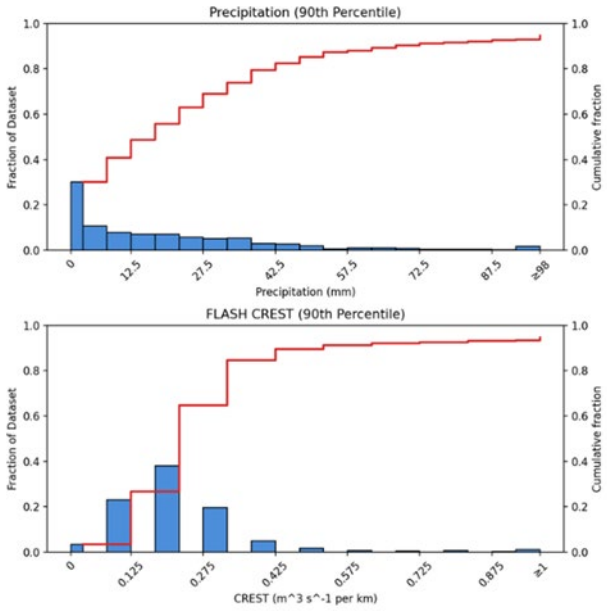


Figure 1: Histograms of MRMS values from MoDOT Closure events; precipitation (top) and unit streamflow (bottom).

Project Information

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