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Research Summary

Predictive Deep Learning for Flood Evacuation Planning and Routing

This research uses deep learning methods, geospatial data from the USGS National Map, and other public geospatial data sources to create a methodology capable of assessing water level rate of change in high risk flood areas. This methodology is used as part of a framework that can determine routing decisions based on safety constraints. These tools build on existing models developed by the USGS, FEMA, and others. The project scope includes analysis of publicly available flood data along the Meramec River basin in Fenton (intersection of I-44 and Route 141) as part of a pilot project in Missouri.

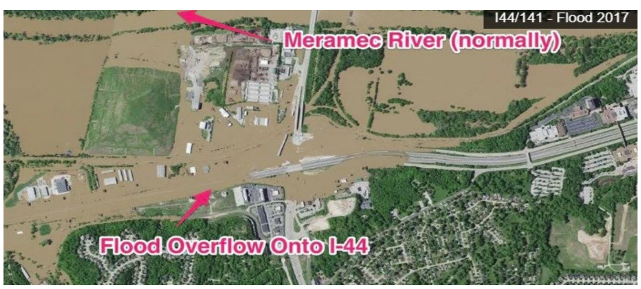
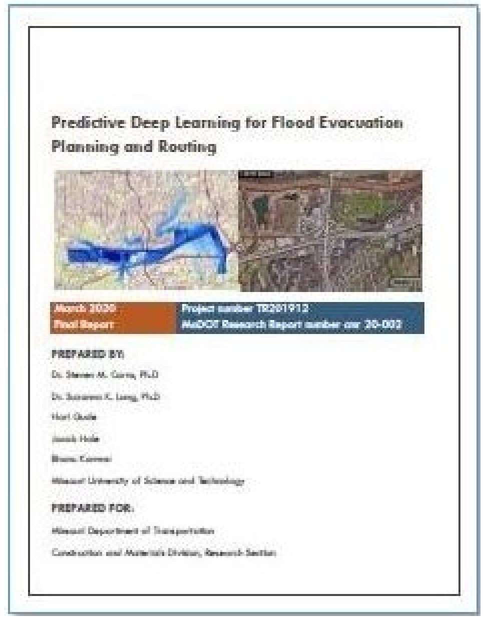


Figure 1: Intersection of I-44 and 141 during Meramec River floods in 2017.

The data was integrated to provide an indication of roads affected by flooding and suggest rerouting schemes along with the indirect costs that would be incurred. This framework introduces a methodology to integrate flood data with transportation data that has not existed prior to this research. This provides combined information on water rise, including when a road will be overtopped. Prior tools only updated


Predictive Deep Learning for Flood Evacuation Planning and Routing

March 2020
Final Report

Project number TR201912
MoDOT Research Report number cmr 20-002

PREPARED BY:

Missouri University of Science and Technology

PREPARED FOR:

Missouri Department of Transportation
Construction and Materials Division, Research Section

flood inundation information at six-hour intervals using data provided by NOAA.

While useful for response planning for a widespread flooding events, this is of limited use in traffic rerouting. As this inundation data was not designed with transportation systems in mind, there is no existing methodology available to match the flood data to transportation system data. Neither is there a methodology available specifically to determine how to best redirect traffic based on flood data while providing the added costs for this rerouting.

> *"In addition to providing updates at a time step that better maps with traffic planning, the root mean square prediction error from these deep learning algorithms is 0.453—less than half the RMSE of current techniques..."*

The algorithms developed in this research identify the patterns in river gauge behavior to predict gauge height at 15-minute intervals, allowing plans to be made based on events occurring every quarter of an hour rather than quarter of a day. In addition to providing updates at a time step that better maps with traffic planning, the root mean square prediction error from these deep learning algorithms is 0.453—less than half the RMSE of current techniques based on physics-based models employed by the USGS, which is 1.065. This corresponds to an improved accuracy of more than seven inches of water level, provided on a time-scale increase of twenty-four.

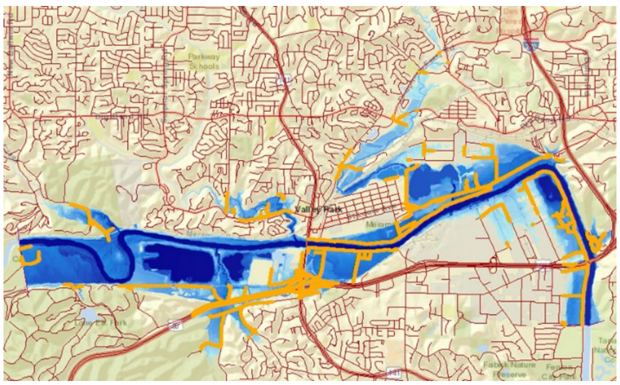


Figure 2: Closed Road Segments for Flood Inundation Profile of 45ft for Valley Park, Missouri.

The framework also provides precise information on how traffic can be rerouted the most effectively to avoid high risk areas and takes into account traffic that is already in route, making it possible to dynamically change traffic based on changes in flood predictions. This makes it possible for transportation safety or disaster planners to create tools specific to their region in the event of a flooding event and when an event occurs, it provides a method to predict when roads are no longer safe for motorists. In addition to the actual rerouting of traffic, this framework determines the time added by modifying the route and calculates the total indirect costs incurred, a capability that did not exist prior to this project.

Project Information

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PROJECT START/END DATE: February 2019 – December 2019

PROJECT COST: $86,548

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