



Validating floodplain mapping with high-resolution satellite imagery will improve Iowa DOT's flood warning capabilities.

# RESEARCH SOLUTIONS

## Validating floodplain maps and improving flood warnings at Iowa's bridges

To protect the state's roads and bridges from flooding hazards, Iowa DOT works with partners to develop technical capacities that predict and communicate the time, location, and severity of flooding for the state's transportation infrastructure. Using high-resolution satellite mapping (HRSM) may provide information that can significantly improve the spatial and temporal extent of possible flooding. New mapping methods will support Iowa DOT in providing more accurate and actionable flood warnings.

### THE NEED

As flooding continues to become more frequent and widespread, a warning system is imperative for the safety of motorists, transportation infrastructure, and the general population. Currently, the [Iowa Flood Center](#) (IFC) develops floodplain maps used by the Federal Emergency Management Agency for decades. These maps are supported by U.S. Geological Survey and IFC stream gauges in 475 locations across the state. The [Iowa Flood Information System](#) provides real-time and forecasted streamflow values for up to five days at more

than 1,100 locations. The floodplain maps and streamflow forecasts are fed into Iowa DOT's BridgeWatch, a web-based monitoring tool that generates flood hazard predictions at bridge locations.

The accuracy of the results produced by numerical models for decision making is largely unknown because on-the-ground information from measurements and visual observations is scarce and prohibitively expensive to obtain. While 475 real-time observation points are more than in other states,

many of Iowa's nearly 24,000 bridges lack forecasts that would provide information about the area's accessibility and determine needed action during flooding events.

New technical resources are needed to improve model outputs and provide more accurate simulated floodplain maps. One resource is offered by the increasingly available HRSM, which covers extensive spatial and temporal scales and benefits from continuous quality improvements and frequent updates. Iowa DOT wanted to explore using



**“This work validated a method to support improving flood predictions using publicly available data. We’re getting closer to having a highly accurate and actionable flood warning system.”**

**— JIMMY ELLIS,**  
Iowa DOT Transportation Engineer Manager

HRSM for improving the quality of floodplain mapping to support a robust flood warning system.

## RESEARCH APPROACH

To assess the accuracy of current floodplain maps, researchers first chose two study sites — one in Fredericksburg and one in Traer — with a history of flooding and reliable stream gauge data attached to bridges. Satellite imagery from a third-party source included resolution down to 1.5 feet and a high sampling rate, producing images several times a day. An examination of images from one week before to one week after the flood events captured their full progression and allowed researchers to create manually extracted flood maps.

A pixel-by-pixel comparison between the manually extracted maps and the existing floodplain predictive maps identified differences such as a location that the predictive flood map showed as dry but the HRSM-based map indicated flooding, which illustrated the overall accuracy of the existing floodplain maps. Then researchers explored automating flood mapping from HRSM using specific data processing and post-processing techniques. Using the results of the second research phase, researchers provided a detailed explanation of how further application of HRSM could improve Iowa DOT’s flood warning system through the BridgeWatch platform.

## WHAT IOWA LEARNED

The comparison of existing floodplain maps and HRSM-based maps showed that the automatically extracted HRSM maps are more scalable and robust than manually extracted maps and more consistent with currently used maps, demonstrating the value of HRSM-validated flood maps to the state’s flood warning system.

To add HRSM maps into the BridgeWatch warning system, Iowa DOT could:

- Automate HRSM map extraction for all bridge sites in flood-prone areas.
- Design a machine-learning algorithm using high-resolution satellite imagery and stream sensors to identify inundation patterns at bridge sites not currently covered by predictive modeling.
- Include asset management and traffic impact information in the flood warning system to ensure continued mobility in case of flooding.

Validating flood inundation modeling with these new analysis tools applied to high-resolution satellite imagery will support advanced capabilities in flood detection and hazard assessment.

## PUTTING IT TO WORK

Iowa DOT is considering additional research to expand the functionality of

the Iowa BridgeWatch flood warning system. The agency and other partners, including the [IFC](#), will continue efforts to merge tools and capabilities to predict flooding with high spatial and temporal resolution and determine needed actions.

## ABOUT THIS PROJECT

**PROJECT NAME:** [Actionable Flood Warnings Based on Ground-Truth Data to Support Iowa DOT BridgeWatch Platform Final Report | Technical Brief](#)

**PROJECT NUMBER:**  
SPR-RE22(016)-8H-00

**REPORT DATE:** February 2024

**PROJECT CHAMPION:**  
**Jimmy Ellis, P.E.**  
Transportation Engineer Manager  
Iowa DOT Bridges and Structures  
[jimmy.ellis@iowadot.us](mailto:jimmy.ellis@iowadot.us)  
515-233-7949

**TECHNICAL ADVISORY COMMITTEE:**  
David Claman, Witold Krajewski,  
and Samuel Sturtz.

**PROJECT MANAGER:**  
**Khyle Clute, P.E.**  
SPR Research and Pooled Fund  
Programs Manager  
Iowa DOT  
[khyle.clute@iowadot.us](mailto:khyle.clute@iowadot.us)  
515-239-1646

**PRINCIPAL INVESTIGATORS:**  
**Ibrahim Demir, Ph.D.**  
University of Iowa  
[ibrahim-demir@uiowa.edu](mailto:ibrahim-demir@uiowa.edu)  
319-335-5780

**Marian Muste, Ph.D.**  
University of Iowa  
[marian-muste@uiowa.edu](mailto:marian-muste@uiowa.edu)  
319-384-0624

**IOWA DOT RESEARCH:**  
[iowadot.gov/research](https://iowadot.gov/research)  
[ideas.iowadot.gov](https://ideas.iowadot.gov)