Understanding how changing storm patterns are likely to impact flooding into the future can guide the design of resilient transportation infrastructure.

RESEARCH SOLUTIONS

Understanding climate and flood predictions for resilient infrastructure design

Iowa DOT uses analyses of past flood events to design sustainable infrastructure across the state. As storms become more frequent and severe, however, the agency wants to ensure that its roads and bridges will be able to withstand heavier rainfall and increased flooding. To understand how future floods will affect Iowa's communities, researchers developed new methods for analyzing historical events and an online tool anyone can use to estimate hydrological impacts for the next 75 years.

THE NEED

Iowa's roads and bridges are designed to withstand storms and potential floods that are only predicted to happen once every 50 or 100 years. Extreme rainfall events, however, have become more common and bring more water, causing larger peak stream flows and flood risks. The storms that used to happen once every 100 years are now more frequent, and numerous studies on future climate estimates predict the trend will continue.

Scientists have traditionally used historical stream gauge data and statistical analyses to estimate storm impacts around the state. These tools, however, have not been able to produce estimates at the community level, nor consider the changing climate. To make sure the state's transportation infrastructure will be resilient in future conditions, Iowa DOT wanted accurate predictions of how much water future storms may bring and how often floods may occur.

(continued)

"We've seen bigger and stronger storms over the last decade. With these research results we can design infrastructure to better withstand the flooding we can expect to see in the future."

— **JIMMY ELLIS,**
Iowa DOT Preliminary Design Unit Leader

RESEARCH APPROACH

An understanding of historical flooding in Iowa and existing methods to predict peak stream flows identified the shortcomings in current flood frequency estimation methods. Using almost 20 years of data, researchers compared existing methods to a new tool from the Iowa Flood Center to predict peak flows in 445 Iowa communities.

The Iowa Flood Information System (IFIS) provides current and forecasted stream flows and potential flooding for up to five days at more than 1,000 locations in the state. The model powering this system simulates the water's trajectory from rainfall and runoff patterns to streamflow. Variables incorporated in the simulation include topography, soil moisture levels, and evaporation rates.

Next, downscaling existing climate models—which generalize predicted impacts over large areas—provided a more accurate way to predict site-specific changes. Combining the high-resolution climate models with IFIS data produced a unique new method for understanding flood frequency at a community scale. Simulations with two commonly used climate scenarios, one where emissions peak around the year 2040 then decline, the other in which emissions continue to rise throughout the 21st century, demonstrated potential peak stream flows from 1950 to 2100.

WHAT IOWA LEARNED

The performance comparison of flood risk estimation methods illustrated that IFIS was more consistent in predicting real-time flooding across different drainage areas. After combining the refined climate models with IFIS, the analysis indicated increased flood risks across the state, especially in high-emission scenarios and toward the end of the 21st century.

Based on the new flood analysis method, researchers developed the publicly available Iowa Flood Frequency and Projections Tool to illustrate how often flooding may occur across Iowa up to the year 2100. Users can input an address and select the nearest stream segment to see flood frequency estimates under different scenarios. In the more detailed version, decision makers, engineers and others can change emissions projections, climate models, and time periods to estimate and compare the frequency of floods in a variety of circumstances.

PUTTING IT TO WORK

Past floods in Iowa indicate the potential severity and resulting damage that could occur in the future. While Iowa DOT will continue to balance many factors in designing, building, and maintaining infrastructure, this research indicates designs need to account for more frequent and severe storms.

With the understanding that the tools will continue to be refined and the information updated, this research is already informing efforts to make roads and bridges more robust and able to remain resilient after being inundated. In addition to updating building standards, Iowa DOT is already using the data to redesign segments in two of the state's major highway corridors.

ABOUT THIS PROJECT

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