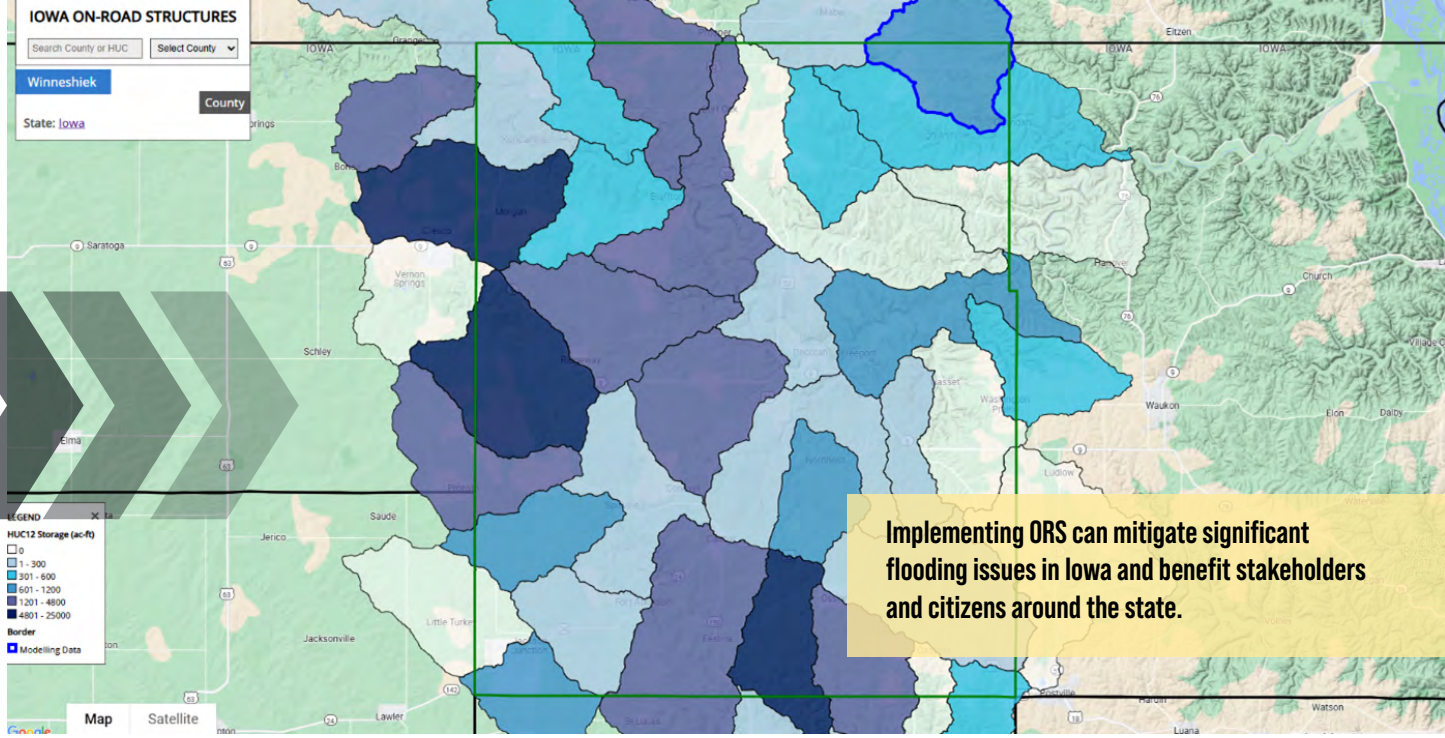

RESEARCH SOLUTIONS

Installing on-road structures to mitigate the impacts of flooding

Improving flood resistance has become a top priority in Iowa after an assessment estimated that extreme weather in the state, primarily flooding, had generated losses of approximately $1.9 billion. An alternative culvert design could help county road departments and Iowa DOT achieve this goal by temporarily retaining stormwater during heavy rain, slowing the flow of water and protecting areas downstream.

THE NEED

Approximately 1,300 federally declared disasters occurred in Iowa counties from 1989 to 2022. Flooding caused about 80 percent of these disasters. During heavy rainfall events, water flows quickly through culverts and combines with other downstream flows that may damage roads, bridges, farmland, and communities. An on-road structure (ORS) provides a nontraditional approach to decreasing the flow of water downstream when precipitation is heavy. An ORS replaces a culvert with an earthen dam equipped with pipes that slowly channel the water into the culvert.

Several counties in Iowa have already replaced a traditional culvert with an ORS, and anecdotal evidence indicates that ORS have had a positive impact on mitigating flooding during extreme rainfall events. To implement additional ORS, researchers used spatial analysis to identify potential future sites throughout the state, allowing agencies to move forward with flood mitigation strategies and planning.

RESEARCH APPROACH

This project sought to create a geospatial database that identifies suitable ORS locations, models the effectiveness of the ORS, and makes the results accessible. A geographic information system (GIS) analysis identified all suitable ORS locations by watershed, evaluating the flood storage, expected pool

(continued)

"This project has contributed to a solution to the large flooding problem in Iowa that will benefit numerous stakeholders and citizens around the state."

— LEE BJERKE,
Secondary Roads Research Engineer

areas, and drainage areas at each potential location. To further identify the ORS locations that could provide maximum peak flow reduction benefits, researchers developed a methodology that automated hydraulic design and analysis using Python scripts in the spatial analysis of six small (HUC12) watersheds in the state.

The benefits of peak flow reduction were quantified for these six watersheds using GHOST (Generic Hydrologic Overland Subsurface Toolkit), a rainfall runoff model tested and validated across watersheds in Iowa. A web-based platform developed in this project allows stakeholders to access the data generated by the project along with the planning designs for the six HUC12 watersheds.

WHAT IOWA LEARNED

The spatial analysis identified approximately 250,000 potential ORS implementation sites in Iowa with a combined storage capacity of 2 million acre-feet and a pool area covering 900,000 acres, representing about 2.7 percent of the state. The results of the evaluation of the six HUC12 watersheds showed, on average, an 18 percent peak flow reduction for a 50-year storm event scenario. Because the project evaluated only a small sample of ORS, the peak flow reduction could increase after additional ORS are evaluated.

The modeling results also indicated that peak flow reduction is not necessarily correlated with the number of ORS in a watershed, but by the percentage of the watershed regulated by ORS.

Stakeholders can view a map of ORS locations, expected pool and drainage areas, structure designs, and inflow and outflow hydrographs.

PUTTING IT TO WORK

The geospatial datasets created by this project are a critical resource for future ORS implementations. Additional analyses that could build upon this current work include:

- Extending the planning design scripts to cover the approximately 1,600 HUC12 watersheds in Iowa.
- Developing a hybrid modeling approach that combines hydrologic modeling with machine learning techniques to enable a more efficient assessment of HUC12 watersheds.
- Coordinating ORS efforts with ongoing flood resiliency planning in Iowa.
- Conducting economic analyses to highlight the fiscal benefits of ORS to secure funding for future implementations.
- Exploring the beneficial water quality impacts of ORS, such as a reduction of phosphorus from agricultural fields reaching bodies of water.

ABOUT THIS PROJECT

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