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Using math to improve disaster recovery

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Colorado native Heidi Hurst knows how devastating flooding can be in her moutainous hometown.

The text message Heidi Hurst received from her father contained only four words: "headed for higher ground." Sitting in a Harvard classroom, she felt helpless as her father frantically packed the car to escape floodwaters that were rapidly approaching the family's Colorado home.

The rushing floodwaters came, but thankfully the family's home was spared.

Not everyone in her hometown was so fortunate. The combination of widespread wildfires and days of torrential rain in the fall of 2013 led to some of the worst flooding the region had seen in more than a century. Homes were destroyed, bridges washed away, and the recovery efforts took months.

As she watched the recovery progress through news reports and heard about the struggles of friends and neighbors back in Colorado, Hurst developed an interest in improving the nation's disaster recovery systems.

This past summer, she got a chance to make an impact during an internship at the Federal Emergency Management Agency (FEMA). Hurst, A.B. '16, an applied math concentrator at the John A. Paulson School of Engineering and Applied Sciences, developed a tool to help officials determine optimal locations to open disaster recovery centers (DRC) after a devastating emergency.

DRCs, which are typically established about 10 days after a disaster and remain open for several months, are centers where survivors can access long-term resources.

"DRCs are not emergency shelters," Hurst explained. "They are centralized resource locations. You would go to a DRC if you needed information on how to get a grant to fix your house, or if you wanted to receive crisis counseling, or needed information on how to get funeral costs reimbursed."

Hurst created a computer model using FEMA disaster information that evaluates suggested DRC locations based on population data. By incorporating information on how the population is spread across a particular county, the model highlights the proportion of the county's residents who can reach a DRC within a given time frame (usually an hour). The model also takes into account the transportation infrastructure survivors will use to reach those DRCs.

"It's important to consider the infrastructure that is still in place and how we can support survivors based on what they are actually experiencing," she said. "It doesn't do survivors any good if a DRC is set up only a few miles away, but the only way to get there is over a bridge that has been washed out."

While developing the model, Hurst also drilled down on social vulnerability data, such as housing, language skills, and income. Incorporating those factors into decision-making is critical because residents who don't speak English or who don't have access to a car, a cell phone, or the Internet will have a much more difficult time reaching a DRC, even if it is only located a few miles from their home.

Though Hurst only scratched the surface during her FEMA internship, she is hopeful that her project will continue, and that FEMA employees will add more detailed elements to her basic model. The ideal tool would allow a user to quickly determine optimal DRC locations based on a wide range of data, from population characteristics to the needs of local communities.

The ultimate goal is to streamline the process FEMA officials use to identify DRC locations, which would bring essential resources to survivors as fast as possible, she said.

"This model could have a measurable impact on people's lives and how quickly a community can return to normal. This is not just some really elegant algorithm or a beautiful theory, but something that could actually make a person's life better," she said. "That's what I enjoyed most about working on it—the ability to combine empathy and analysis in a really unexpected place."

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