Jason O. Hallstrom, Ph.D.
Deputy Director and Director of Technology, Institute of Computational Ecology
Associate Professor, School of Computing
Clemson University

Emergency Preparedness: Are We Ready for a 21st Century Hugo?

The House Committee on Homeland Security's
Subcommittee on Oversight and Management Efficiency

Chairman Duncan, Ranking Member Barber, and Members of the Subcommittee, welcome to Clemson University. I know that for many of you, this is a welcome back. We're honored to have you on campus today.

My name is Jason Hallstrom and I am a computer scientist in the School of Computing here at Clemson, and I have the privilege of serving as the Deputy Director and Director of Technology for Clemson's Institute of Computational Ecology.

As the Subcommittee is well-aware, 2014 represents a bitter anniversary, marking 25 years since Hugo's landfall on the South Carolina coast. With wind speeds in excess of 130mph, the storm resulted in 49 deaths and approximately $9B in damage. This wasn't the first Category 4 storm to hit our coast, but its ferocity fundamentally reshaped our perceptions of the tremendous impacts such storms can impose. In the quarter-century hence, South Carolina has been fortunate to avoid the brunt of subsequent superstorms — quite narrowly, it is worth noting, in the cases of Irene and Sandy, both of which dwarfed the aggregate economic impact of Hurricane Hugo. As we witness apparent increases in the frequency and severity of Atlantic storm systems, emergency preparedness could not be more paramount. Thank you for considering this important topic and for the opportunity to provide testimony to the Subcommittee today.

While the timing is uncertain, the potential for another superstorm to make landfall on our coast is not. That is simply an unfortunate inevitability that we must face. In assessing our preparedness for such an event, there are two important planning dimensions to consider. The first is our capacity to plan *proactively*, before the storm makes landfall. This involves our ability to predict, to track, and to gauge the severity of the storm in a timely fashion, with high fidelity, well in advance of its impact. This capacity sets an upper bound on our ability to mobilize citizens out of harm's way, to establish appropriately scaled response teams, and to establish infrastructure contingencies. The second dimension to consider is our capacity to plan *reactively*, after the storm makes landfall. This involves our ability to dynamically monitor infrastructure and natural resource impacts as they occur, setting an upper bound on our ability to direct response efforts to where they are needed most, and to reduce the duration and severity of infrastructure and resource disruptions. Today, I'm pleased to offer optimistic outlooks on both of these fronts.

Since 1989, NOAA and the National Weather Service have made significant improvements to their data collection, modeling, and forecasting infrastructure. The nation's radar network has been enhanced to provide not only improved resolution and sensitivity, but also the ability to acquire wind speed and direction data, both of which are instrumental in hurricane modeling. The GOES satellite network has doubled in size, with attendant advancements in satellite stabilization, storm localization, detector optics, and available energy, enabling continuous high-resolution imaging. More frequent reconnaissance flights and higher density inflight data collection complement these continuous streams. Together, these datasets and improved forecasting models have helped to reduce the National Hurricane Center's 24-hour track error by approximately 40%, providing significant benefits to evacuation planning activities, estimated at $1M per mile of evacuated coastline. While hurricane patterns will always be stochastic phenomenon, the important takeaway is that proactive monitoring capabilities were not a significant operational bottleneck in 1989, and they are unlikely to be operational bottlenecks in the future.

I promised an optimistic outlook on both planning fronts, and that remains true. But my optimism on the reactive front stems from the tremendous opportunities that I see for improving our state and nation's capacity to dynamically adapt and respond to hurricanes and other emergency events as they occur. The improvements that we've witnessed in our portfolio of proactive monitoring technologies are unquestionably impressive, but reactive monitoring technologies have witnessed a sea-change. Ironically, the catalyst for this paradigm shift arrived in a small package — a family of computing devices that we now refer to as *motes.*

This unusual name reflects a tiny form-factor, ranging from the size of a Rubik's Cube, to the size of a matchbox or a quarter. Each device is capable of sensing, processing, and communicating information from its hosting environment. Mote networks enable applications in locating sniper fire, monitoring wildfire conditions, assessing the structural integrity of buildings and roadways, and classifying intruders near critical infrastructure. Looking to the future, these devices are likely to be even smaller and more robust, making it possible to seamlessly integrate in situ monitoring capabilities within our buildings, our roads, and our utility infrastructure. In the event of a natural or manmade disaster, the resulting sensing fabric could be used to provide near instantaneous feedback on the type, degree, and location of damage. Emergency management decisions would be optimized to rapidly commit resources and personnel to where they were needed most.

But this is still a vision. The hardware, software, and networking foundations necessary to deploy and manage statewide sensing infrastructure suitable for emergency response are still evolving. I believe that Clemson can play an important role in this evolution based on our work with the Intelligent River® program.

The Intelligent River® brings together faculty and students from across campus to develop a new sensing infrastructure[1]. While the infrastructure design relies on mote networks, it is a fully integrated solution that enables end-users to collect, share, and utilize a broad spectrum of in situ data at dense temporal and spatial scales. The result is a system that enables fine-grained, long-lived, low-cost in situ monitoring at local, regional, and landscape scales and supports meaningful analyses of the resulting data. Our team is managing Intelligent River® deployments throughout the state, including an ongoing deployment along the 312-mile reach of the Savannah River, from the headwaters in North Carolina to the port in Savannah.

In these deployments, our monitoring emphasis is on water quality, but the design of our toolset is sensor-neutral. So while the type of data being collected in the Savannah Basin could help to assess the types of drinking water impacts observed during Hurricane Irene, virtually any type of sensor can be deployed within this infrastructure, across a wide range of challenging environments. I believe that the Intelligent River® represents an important foundation for growth as we consider how to improve our state's ability to efficiently respond to hurricane events and other natural and manmade emergencies.

I would like to thank the Subcommittee once again for considering this important topic and for the opportunity to provide testimony today. I am happy to answer any questions you may have.

---

[1] This work is supported through competitive awards from the National Science Foundation (CNS-1126344, CNS-0745846).