FloodCast: A Framework for Enhanced Flood Event Decision Making for Transportation Resilience

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Imagine flood response capabilities being dramatically improved by instantaneous inundation and water depth data delivered to smart devices demonstrating exactly where imminent risks exist. Imagine that information being delivered to emergency responders, public safety officials and transportation decision makers who immediately disseminate that information to the public. Imagine the lives saved from people knowing where not to go during wet weather events.

As we have seen most recently with Hurricanes Harvey, Irma, Maria and Nate, flooding has a significant, damaging impact on transportation systems and its users. Many lives have been lost when cars are swept away by flood waters and drivers are unable to escape their vehicles in time. Emergency response and state transportation agencies often lack the integration of real-time forecast information to incorporate into their asset management and communications systems to expeditiously close roads, bridges, tunnels, etc. and thus to prevent loss of human life. This information may consist of now-casts, short-range and medium-range forecasts being developed by the National Water Model.

To bridge this gap and improve state DOT flood planning, risk management, mitigation, preparedness operations and emergency response activities, the National Cooperative Highway Research Program (NCHRP) initiated a national research project entitled **FloodCast.** The project is overseen by a panel led by officials from CalTrans and Delaware DOT and comprised of representatives from American Association of State Highway and Transportation Officials (AASHTO), NOAA, USGS, research universities and private consulting firms. The research team, led by Dewberry, an engineering consulting firm based in Virginia and including Venner Consulting, is developing a data architecture and framework for a flood forecasting decision-support prototype tool to make rapid response decisions and communicate them during flooding events to reduce impacts to transportation infrastructure and its users.

Approach and findings

Several steps were taken before Dewberry began the framework design. A literature review identified numerous resources to support flood forecasting, response and recovery. Many of these resources could be readily integrated into a framework to support state DOTs in planning for, responding to and operating during floods. Other resources would require modification before being integrated into a flood forecasting or "floodcasting" framework. We determined a floodcasting framework would need to include certain components to be effective, which led to the development of the FloodCast Capability Maturity Model (CMM) to help state DOTs define the key data, technologies and practices required to effectively achieve floodcasting progress over time. These components or 'capability dimensions' were: meteorology; hydrology and hydraulics; asset management; communication and information transfer; and incident management. These CMM capability

Capability Maturity Model Components.

dimensions had tiers indicating levels of maturity toward that dimension and could be later used as a pathway for a state DOT to improve its capabilities along each dimension.

Dewberry created a FloodCast prototype based on the research results. We also performed requirements and a gap analysis to identify, from a state DOT perspective, the essential capabilities a floodcasting platform should have to support their needs. During this time, our team collaborated with a number of state DOTs across the country with the goals of: 1) capturing a range of geographic regions with varying flood hazards; and 2) engaging with appropriate staff with job responsibilities related to flood forecasting, response and recovery. During our interaction with these state DOTs, Dewberry provided demonstrations of the prototype user interface and identified participant DOTs representing a mix of novice and advanced practitioners with respect to the key dimensions of flood forecasting, response and recovery. Examples of concerns gathered from state DOTs and a summary of their needs follow.

- *Meteorology*: most state DOTs consult predictive weather forecasts for flood events most commonly from: NWS, NOAA, USGS, NHC and FEMA. Data is gathered separately from each source. Time is then needed for creating an update rather than having one central system to store all weather and hydrologic data. *Need*: one central data collection system.
- *Hydrology and Hydraulics*: a few state DOTs use USGS rating curves or StreamStats program to estimate inundation extent and depth predictions for ungauged locations. *Need*: rapid translation of stream flow predictions developed by the National Water Model to extent and depth predictions.
- *Asset Management*: many state DOTs have some sort of asset management system, but they can be limited or incomplete, not in a geospatial format, or the asset fragility information is questionable. *Need*: asset data should include key design attributes to support impact assessment.
- *Communications and Information Transfer*: many dispatch alert systems are rarely automated and occur during or post-event rather than delivering predictive information. *Need*: one-click automated communication tools to streamline internal and external dissemination efforts.
- *Incident Management*: agency staff have institutional knowledge of flood-prone areas subject to loss. *Need*: a data system with flood-prone areas identified, allowing for rapid synthesis of all flood event analytics to facilitate both response and post-disaster recovery and reimbursement activities.

Next steps

We are working with interested partners, particularly additional state DOTs, to continue to refine and improve the prototype. Dewberry is utilizing the information gathered during state DOT conversations to form specifications, which will take into account both DOT-defined requirements and the limitations in the data and technology available to meet the requirements. Our team is also focused on identifying appropriate data standards—a uniform format for each data type to improve compatibility and interoperability for the FloodCast prototype. We are pursuing answers to issues raised during the requirements analysis including finding solutions to convert ungauged location data generated by the National Water Model to water depth and inundation extent, ultimately increasing the quality of information state DOTs can use for flood event decision-making. For project questions, please contact: Caroline Whitehead cwhitehead@dewberry.com. ■

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Participating State DOTs for the FloodCast Requirements Analysis.

FloodCast System Display.