Levee Breach Consequence Model Validated by Case Study in Joso Japan

Flood risk assessments for levees are based on hydraulic and consequence modeling to understand the potential impacts of a breach. These models are difficult to validate due to a lack of available data on the extreme and infrequent events they reproduce. A levee overtopping event on the Kinugawa River near Joso, Japan provided a unique case study to validate breach and consequence models. The breach and aftermath were observed by citizens, television news, and government agencies because of its urban setting. In September 2015, the levee overtopped and breached in three locations due to intense rains from the 17th and 18th tropical cyclones. Several homes were destroyed and the city center flooded up to 3 meters deep. National and local agencies rescued hundreds of people by helicopter from their rooftops and some directly from the rushing water. The well-documented disaster provided data on levee breach progression, flooding, evacuation, and flood fatality rate assumptions in USACE models.

This paper addresses the development, calibration, and breach progression for a combined 1D/2D river hydraulics model in HEC-RAS. It describes how data from social media augmented official sources to create a more complete and accurate data set. Specifically, the breach erosion progression was defined based on multiple sources and recreated in the hydraulic model. The river hydraulics model used observed river stage for boundary conditions and was calibrated to observed flood depths, flood limits, and breach velocities. The calibrated model was then compared to a model containing typical breach parameter assumptions, highlighting the sensitivity of those assumptions to the flood depths and velocities. The hydraulic results were then used in consequence modeling using HEC-LifeSIM as described in the companion paper.

This paper also addresses the HEC-LifeSIM model calibration and describes how data from social media augmented official sources to create a more complete and accurate data set of evacuations, building collapse, and life loss. An HEC-LifeSIM model was built with reported evacuation and sheltering rates, and calibrated to casualty figures. It included a vehicular evacuation simulation. This was compared to default rates in the USACE standard operating procedure and shows the advantage of more accurate river hydraulic modeling and the sensitivity of warnings.