vantage point

Ankle Deep, Knee Deep, or Higher?

Hurricane Amanda and Tropical Storm Boris have already sloshed and wind-blasted their way through Central America. Amanda arrived a week before the official June 1 start of hurricane season, with Boris close behind. It's time to assess our storm surge prediction tools. While such storms generally cause most of their damage along our sea coasts, inland areas experience significant flooding from storm surge. What we all want to know is how much water might we expect? Which neighborhoods will be inundated first, and which roads will be impassable for evacuation or rescue?

If we can predict the direction of a storm and where it is likely to make landfall, we improve our opportunity to prepare for flooding events more realistically in relation to human safety and our built environment. Along large bodies of water such as the Great Lakes, the Atlantic and Pacific Oceans, and the Gulf of Mexico, additional height of water from air pressure changes and winds pushing water inland is called storm surge. But storm surge is not confined to those lands immediately along the waterfront. Through a model called Sea, Lake, and Overland Surges from Hurricanes (SLOSH), the National Oceanic and Atmospheric Administration (NOAA) calculates maximum potential impact and coastal inundation risk assessment based on storm intensity, path, and estimated storm size information from its National Hurricane Center (NHC).

The first difficulty is accurately predicting the storm's track and timing of its landfall. A slight shift can mean a different area will be impacted more severely, and a delayed or expedited arrival coincident with high tide can mean a whole lot more water is pushed inland than had been anticipated. A change in storm intensity affects air pressure, sucking water into low-pressure areas, while a variation in storm size influences how much area will be affected. This is not an easy set of variables to play with, so a series of many SLOSH runs creates a Probabilistic Storm Surge (P-Surge) estimate. Based on SLOSH-based simulations of impacts of each model run and relying on statistical analysis of past advisories' accuracy, P-Surge estimates are posted on the NHC website within half an hour of NHC's storm advisory.

Coastal areas are divided into SLOSH basins for computational purposes, and account for susceptibility related to dense population, low topography, and ports. Each basin is modeled to determine Maximum Envelope of Water (MEOW) by calculating SLOSH runs both left and right of the main storm track. By accounting for various uncertainties in storm forecasting, thousands of SLOSH runs yield MEOWs for worst-case scenarios to aid in evacuation planning. An analysis of all MEOWs for a basin will yield MOMs (Maximum of MEOW runs). Obviously in this short space, this generalized description omits many details of the variables and approaches. For instance, SLOSH does not account for rain flooding, normal river flow, or the impact of waves on top of storm surge. However, for fast model runs and its ability to resolve flows through particular situations, it is an invaluable tool.

But aside from all the math, we want to know the effect of storms on humans and our built and natural environments more directly. SLOSH Storm surge heights are referenced to a vertical datum, with all basins in the contiguous United States updated to NAVD88. Not everyone understands elevation, however, and so NHC forecasts storm surge as height above ground level. This year, NHC released an experimental Potential Storm Surge Flooding Map to help identify the areas where storm surge could cause inundation and what to what depth those areas could expect inundation. NHC calls this a "reasonable worst-case scenario for any given location", with the maps representing inundation levels with a 10% probability of being exceeded. The four-color coding system represents inundation levels up to 3 feet above ground, greater than 3 feet, greater than 6 feet, and greater than 9 feet above ground.

NHC anticipates releasing initial inundation mapping on its website when it issues its first hurricane or tropical storm watch (advising of a possible storm event) or warning (requiring immediate action as arrival of the storm is imminent) and will be updated every six hours, within about a half hour after running P-Surge. No GIS data from this model will be made available during the experimental phase of P-Surge while NHC seeks feedback and suggestions for improvements, need for modifications, and whether it should be integrated into NHC's regular operations.

The National Research Council's 2009 publication "Mapping the Zone: Improving Flood Map Accuracy" devoted a full chapter to the importance of appropriately communicating flood risk. The vast majority of the public understands an estimated level of inundation better than projected water surface elevation. While limited in scope of analysis, as many quick emergency forecast tools are, this new technology may be able provide a broadly understood straightforward advisory that more of the public will heed. ■

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