A Flash Flood Forecasting and Warning System for Urban Settings: A Proof-of-Concept Study

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Forecasting peak flows and stage in medium-sized watersheds (<200 square miles, mi^2) can be problematic, particularly in developed, urban watersheds dominated by rapid rainfall-runoff characteristics. The volume of water available as direct runoff is greater because of the (1) impervious cover and reduced infiltration and (2) hydraulic efficiencies associated with engineered-storm controls (sewers), which reduce the time of concentration and increase the peak stage. The hydrologic response to these extreme-weather events may be measured in minutes (min) and hours (hr), which for emergency management agencies and the public leaves little time for a proactive response.

Allegheny County, Pennsylvania has a long history of regional floods and localized-watershed flooding, which resulted in deaths and millions of dollars in damage to homes, businesses, municipal sewer systems, roads and bridges. A developing collaborative effort between the National Weather Service (NWS), Pittsburgh Weather Forecast Office (WFO), U.S. Geological Survey (USGS), and 3 Rivers Wet Weather (3RWW) will focus on the design and implementation of a flash flood forecasting and warning system. Other potential partners in this effort are the Pennsylvania Department of Environmental Protection and the U. S. Army Corps of Engineers, Pittsburgh District.

A near real-time flow model is proposed for the Pine Creek (67.3 mi^2) and Girtys Run (13.4 mi^2) watersheds. The model will be parameterized using a network of streamgaging stations established using Geographic Information Systems (GIS) analysis, which will focus on basin hydrology and demographics. The stations will be equipped with radio and satellite communication hardware to provide streamflow and stage data to local emergency responders, the NWS WFO, and 3RWW. The data will be used to construct and a NWS flood-routing model (KINEROS2) that will run simulations in advance of an event or in near-real time. The model will interface with the NWS WFO Weather Surveillance Radar 88 Doppler and USGS stage data. As a redundancy, the USGS will pilot a probability-based, one-dimensional, open-channel model to forecast the arrival time and magnitude of streamflow, stage, and surface-water velocity at points downstream of the streamgage locations.

The information generated from these data sources will be transmitted in near-real time and feed a communication network to alert emergency personnel of impending-flood waters.