Reconstruction of flood magnitude, inundation extent and flow patterns in an urban flood

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Record flooding in the Baltimore metropolitan region resulted from 100 – 130 mm of rain over the 14.3 km^2 Dead Run watershed during a period of less than 2 hours on 7 July 2004. Observational and hydraulic modeling studies of the 7 July 2004 flood are used to examine extreme flood response for urban watersheds. Observational resources include storm total rainfall observations from a network of 17 rain gages within the Dead Run watershed, radar rainfall estimates at 15-minute time intervals, partial stage hydrographs from a network of 6 gaging stations within the Dead Run watershed, a 1 meter DEM for the watershed, and survey of high water marks (HWM) over multiple reaches of the surface drainage network of Dead Run. Simulation of flood inundation and flow patterns was carried out using two numerical models: (1) TELEMAC-2D, a finite element model which solves the depth-averaged form of the Navier-Stokes equations, and (2) LISFLOOD-FP, a computationally efficient raster-based coupled 1D/2D model using either kinematic or diffusion wave approximations for propagation of channel flow and lateral diffusion of flow between storage cells in the overbank domain. Whereas TELEMAC-2D can simulate lateral water-surface gradients, 2-dimensional velocity vectors and transverse variations in both channel and floodplain flow, LISFLOOD-FP can simulate complex 2-dimensional flow and velocity patterns on the floodplain. In addition, whereas run times for TELEMAC-2D are prohibitive for flash flood forecasting, the computational efficiency of LISFLOOD-FP is such that inundation forecasting using high resolution grids is feasible..

Central topics examined in this study include estimation of peak discharge and reconstruction of flood hydrographs and flow volume for extreme floods, comparison of rainfall and flood frequency estimates, and assessment of sources of uncertainty in modeling flood inundation patterns and discharge. Model analyses, constrained by HWM observations, illustrate the complexity of flood inundation for the 7 July 2004 flood, especially in the confluence region of the two main tributaries of Dead Run. The timing and extent of flood inundation depends on a range of processes that reflect heterogeneous hydrologic

response of urban watersheds, “downstream” variation in channel – floodplain geometry and urban infrastructure.