Flood-Inundation Mapping for the Blue River and Selected Tributaries in Kansas City, Missouri, and Vicinity, 2012

Overview

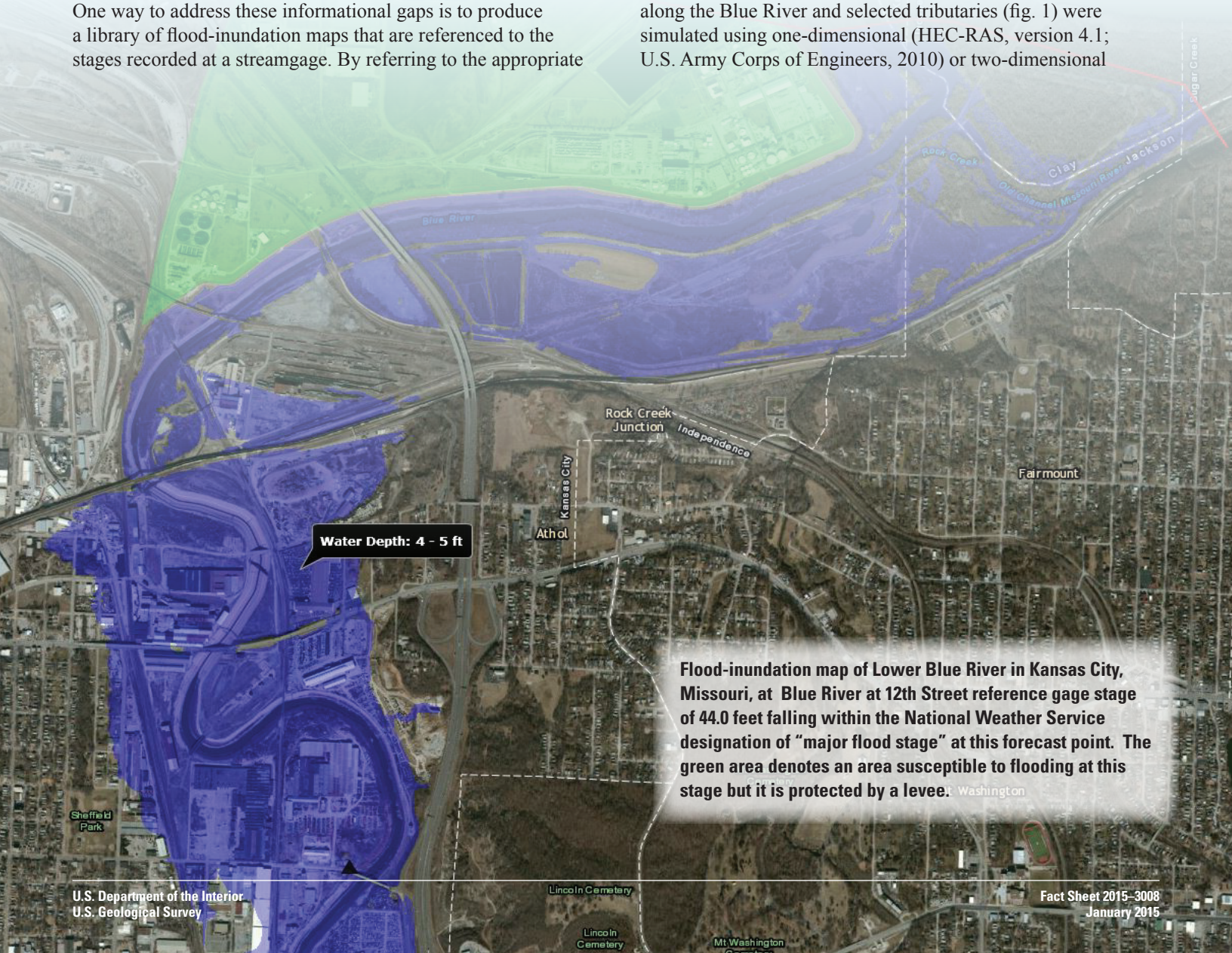
Kansas City, Missouri, has severely flooded many times, most notably in 1951, 1961, 1977, 1984, 1990, 1998, and 2010 (National Oceanic and Atmospheric Administration, National Weather Service, 2014). During the past 30 years these floods resulted in damages within Kansas City costing tens of millions of dollars and more than 25 casualties (U.S. Army Corps of Engineers, 1967; Hauth and Carswell, 1981).

The U.S. Geological Survey (USGS) and City of Kansas City, Missouri, operate multiple streamgages along the Blue River and tributaries in and near the city. Knowledge of water level at a streamgage is difficult to translate into depth and areal extent of flooding at points distant from the streamgage. One way to address these informational gaps is to produce a library of flood-inundation maps that are referenced to the stages recorded at a streamgage. By referring to the appropriate map, emergency responders can discern the severity of flooding (depth of water and areal extent), identify roads that are or may be flooded, and make plans for notification or evacuation of residents in harm's way for some distance upstream and downstream from the streamgage. The USGS, in cooperation with the city of Kansas City, Missouri, developed a library of flood-inundation maps for the Blue River and selected tributaries.

Creation of Flood-Inundation-Map Library

Computation of Water-Surface Profiles

Water-surface profiles showing the distribution of streamflow for a range of stage-flow conditions in 15 mapped reaches along the Blue River and selected tributaries (fig. 1) were simulated using one-dimensional (HEC-RAS, version 4.1; U.S. Army Corps of Engineers, 2010) or two-dimensional



Flood-inundation map of Lower Blue River in Kansas City, Missouri, at Blue River at 12th Street reference gage stage of 44.0 feet falling within the National Weather Service designation of "major flood stage" at this forecast point. The green area denotes an area susceptible to flooding at this stage but it is protected by a levee.

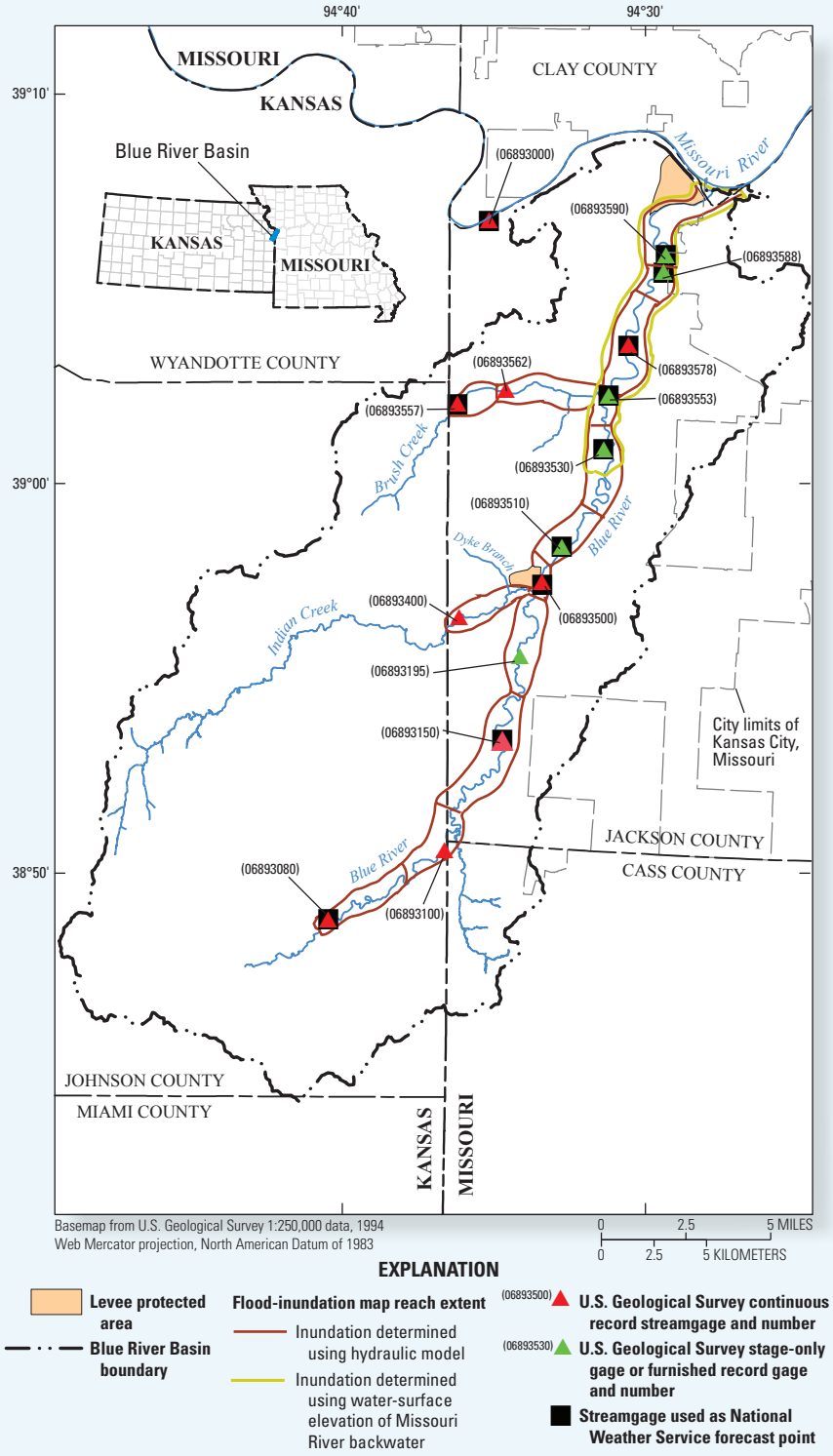


Figure 1. Site map of Blue River and tributary flood-inundation map reaches and streamgages.

(FST2DH, release 3.3.3; Froehlich, 2003) steady-state hydraulic models. Results in Heimann and others (2014) update and increase the resolution of inundation maps produced by Kelly and Rydlund, (2006) and Kelly and Huizinga (2008) and account for Blue River channel modifications (widen, deepen, and straighten channel) completed by the U.S. Army Corps of Engineers in 2010 to increase channel conveyance in the lower Blue River Basin (fig. 2).

Hydrologic Data

The study-area hydrologic network consists of 15 streamgages (figs. 1 and 3). Continuous stream stage generally is measured every 15 minutes, transmitted hourly by a satellite radio in the streamgage, and made available on the Internet through the USGS National Water Information System (NWIS; U.S. Geological Survey, 2014a). The stage-streamflow ratings from nine streamflow-gaging stations and documented high-water marks (Donald Wilkison, U.S. Geological Survey, written commun., 2013) from the June 14, 2010, flood were used in the calibration of the hydraulic models.

Hydraulic Models

Steady-state flow data consisted of flow regime, boundary conditions, and peak flows that produced water-surface elevations at the streamgage cross section that matched target water-surface elevations. Flood-inundation maps were produced for even 1-ft increments of stage that were referenced to the local streamgage datum; the target elevations ranged from about bankfull to the stage corresponding to the 0.2-percent annual exceedance probability flow (equivalent to a 500-year recurrence interval flow). Model calibration was done by adjusting roughness coefficients (Manning's n values) until the results of the hydraulic computations closely agreed with the observed water-surface elevations or stages from the coinciding stage-streamflow rating.

Development of Flood-Inundation Maps

Flood-inundation maps were created in a geographic information system (GIS) by combining simulated water-surface profiles and terrain elevation data (fig. 4). The terrain model data were derived from lidar data and stream channel and bridge surveys at selected locations. Estimated flood-inundation boundaries for each simulated profile in HEC-RAS were developed with HEC–GeoRAS software (U.S. Army Corps of Engineers, 2009), which allows the preparation of geometric data for import into HEC–RAS and processes simulation results exported from HEC–RAS (U.S. Army Corps of Engineers, 2010).

Flood-Inundation Map Delivery

A Flood-Inundation Mapping Science Web site (*http://water.usgs.gov/osw/flood_inundation/*; U.S. Geological Survey, 2014b) has been established to make USGS flood-inundation study information available to the public (fig. 5). The site links to a mapping application that presents map libraries and provides detailed information on flood extents and depths for modeled sites. The mapping application enables the production of customized flood-inundation maps from the map library for the

Figure 2. Channel modifications along the lower Blue River in Kansas City, Missouri.

Figure 3. U.S. Geological Survey streamgage at the Blue Ridge Boulevard Extension, Kansas City, Missouri.

15 study reaches. A link on this Web site connects to the USGS NWIS, which presents the current stage and streamflow at the USGS streamgages to which the inundation maps are referenced. A second link connects to the National Weather Services Advanced Hydrologic Prediction Service (AHPS) Web site (National Oceanic and Atmospheric Administration, National Weather Service, 2014) so that the user can obtain applicable information on forecasted peak stage at forecast points. The estimated flood-inundation maps are displayed in sufficient detail so managers can respond efficiently to flooding and decisions for emergency response can be made accordingly.

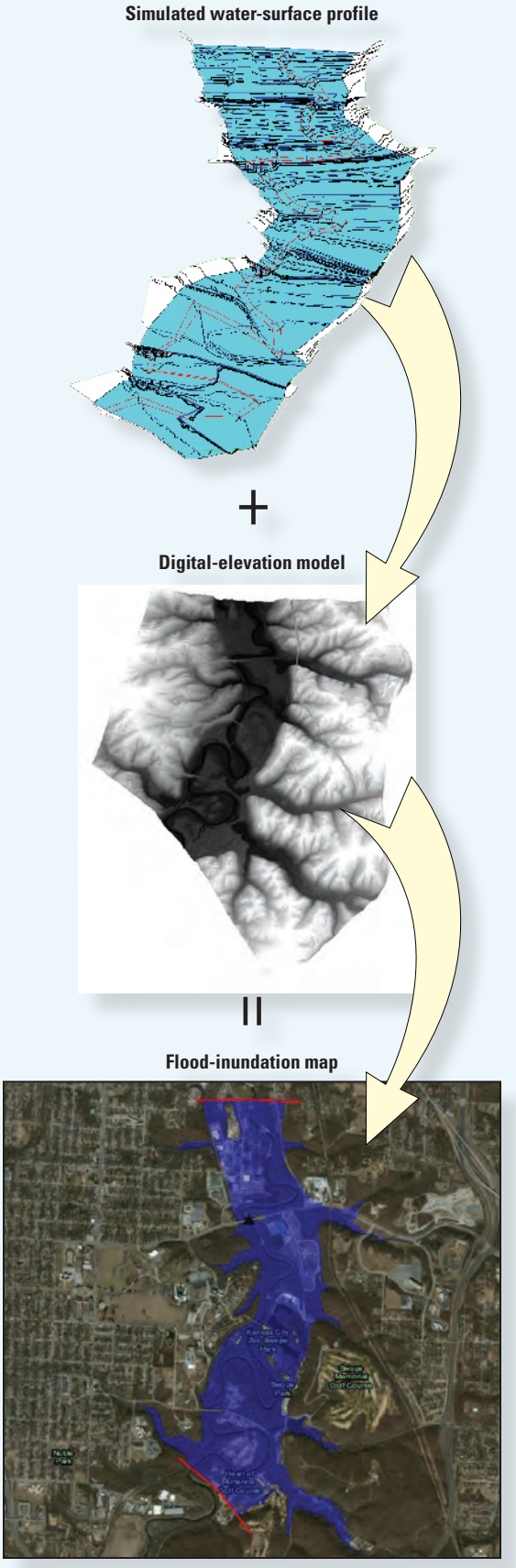


Figure 4. Simulated water-surface profile, digital-elevation model, and developed flood-inundnation map for the Blue River at 63rd Street, Kansas City, Missouri, map reach.

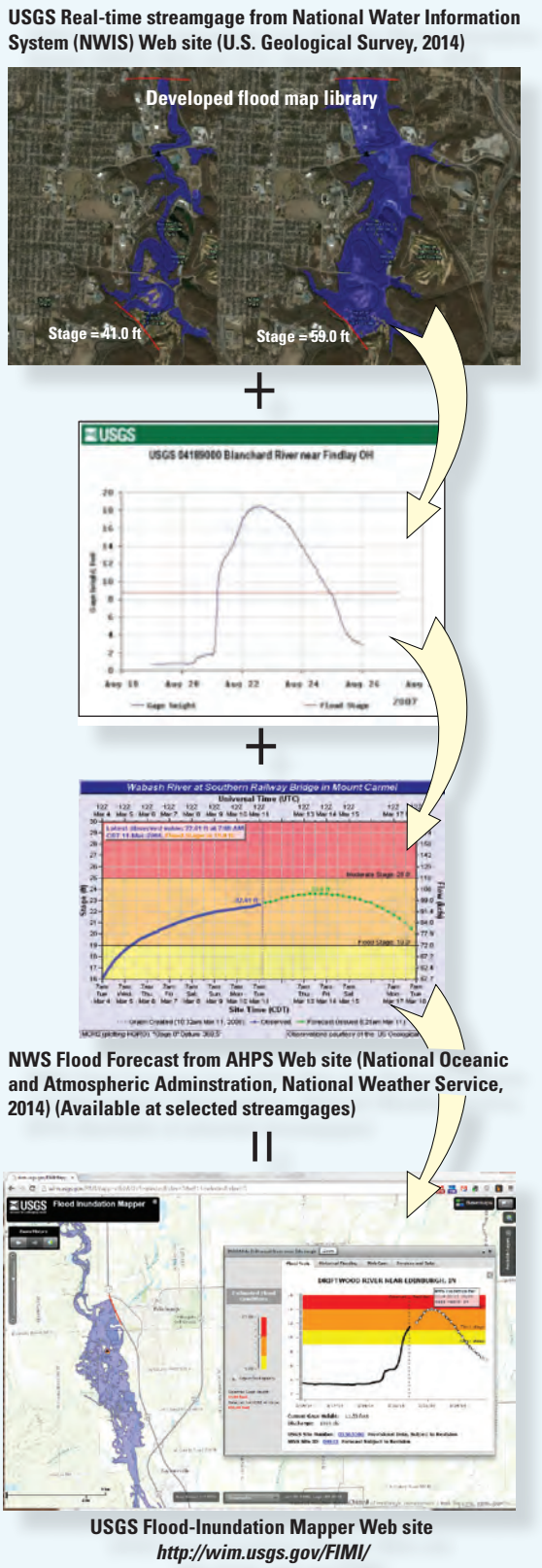


Figure 5. U.S. Geological Survey flood-inundation mapping science Web site components and display.

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