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Prepared in cooperation with the Bandera County River Authority and Groundwater District and the Texas Water Development Board

Flood Warning Toolset for the Sabinal River Near Utopia, Texas

Overview

Floods are one of the most frequent and expensive natural disasters that occur across the United States (Federal Emergency Management Agency, 1996). Rapid, high-water events that occur in local areas—flash floods—are especially difficult for emergency managers to predict and provide advance warning to the public, and insufficient data can hamper postflood recovery efforts. Central Texas is hilly, and it is known as a "flash flood alley" because of its high-intensity rains, shallow soils, and steep terrain, all of which combined can result in loss of life and property damage (Nielsen and others, 2015). For example, the flash flood event during July 2002 claimed 12 lives in central Texas (Slade and Patton, 2003), including 1 in the town of Utopia (Cosgrove, 2002), which is on the east bank of the Sabinal River in a flash-flood-prone area along the Balcones Escarpment (fig. 1). During the flood event, the peak discharge recorded on July 5, 2002, at U.S. Geological Survey (USGS) streamgage 08198000 Sabinal River near Sabinal, Tex. (hereinafter referred to as the "Sabinal gage") (fig. 1), was 108,000 cubic feet per second (corresponding to a stream stage [also called gage height] of 33.74 feet) (Nielsen and Norris, 2007; East, 2016). To put the 2002 flood into context, during a typical year the median daily discharge in the Sabinal River at the Sabinal gage is only about 23 cubic feet per second (U.S. Geological Survey, 2023a).

In 2021, the USGS, in cooperation with the Bandera County River Authority and Groundwater District and the Texas Water Development Board, developed a flood warning toolset for the Sabinal River near Utopia. This study builds on earlier USGS flood work on the Medina River in Bandera County (Choi and Engel, 2019; Engel and Choi, 2019). The newly developed toolset consists of a newly installed USGS streamgage to collect continuous stream stage data (streamgage 08197970 Sabinal River at Utopia, Tex.; hereinafter referred to as the "Utopia gage") (figs. 1 and 2) 13 miles upstream from the Sabinal gage, a hydraulic model developed for the Sabinal River near Utopia, and an online library of digital flood-inundation maps referenced to the stream stage at the Utopia gage.

Creation of Flood Warning Toolset

Hydrologic Data

The stream stage at the new Utopia gage (fig. 2) is measured and recorded every 5 minutes, transmitted hourly to a satellite, and then made available on the internet through the USGS National Water Information System (NWIS) web interface and the USGS National Water Dashboard (U.S. Geological Survey, 2022, 2023b). Continuous discharge records for the Utopia gage are unavailable as of May 2022 because of the short monitoring period of the gage (January 15, 2020, to May 2022) and prolonged dry conditions during the same period. After enough discrete discharge measurements are made at the gage to represent the entire range of the expected conditions, a stage-discharge rating curve (a relation between stream stage and corresponding discharge at a cross section of a stream) will be developed and used to compute discharge. For the current study, a synthetic rating curve was developed by using a regional regression method to determine discharge corresponding to the modeled stream stages at the Utopia gage (Choi, 2023a, b).

Hydraulic Model

To simulate potential flood-inundation areas, a hydraulic model was developed using the U.S. Army Corps of Engineers Hydrologic Engineering Center River Analysis System program (U.S. Army Corps of Engineers, 2016) for a 10-mile reach of the Sabinal River and a 7-mile reach of the West Sabinal River near Utopia (fig. 1). The hydraulic model was used to depict the hydraulic characteristics of the study reach. The input parameters for the model were prepared using high-resolution digital elevation data, land cover data, field surveys on structures and a channel cross section, and the synthetic stage-discharge rating curve at the Utopia gage. The hydraulic model was then used to develop a library of 35 flood-inundation maps that show potential inundation areas associated with simulated stream stages ranging from 11 to 28 feet in half-foot increments at the Utopia gage. The highest stage value of 28 feet was based on the estimated peak stage of the Sabinal River at Utopia during a major flood event on July 5, 2002 (Choi, 2023a). An example of a flood-inundation map for a simulated stream stage of 28 feet at the Utopia gage is shown in figure 3.

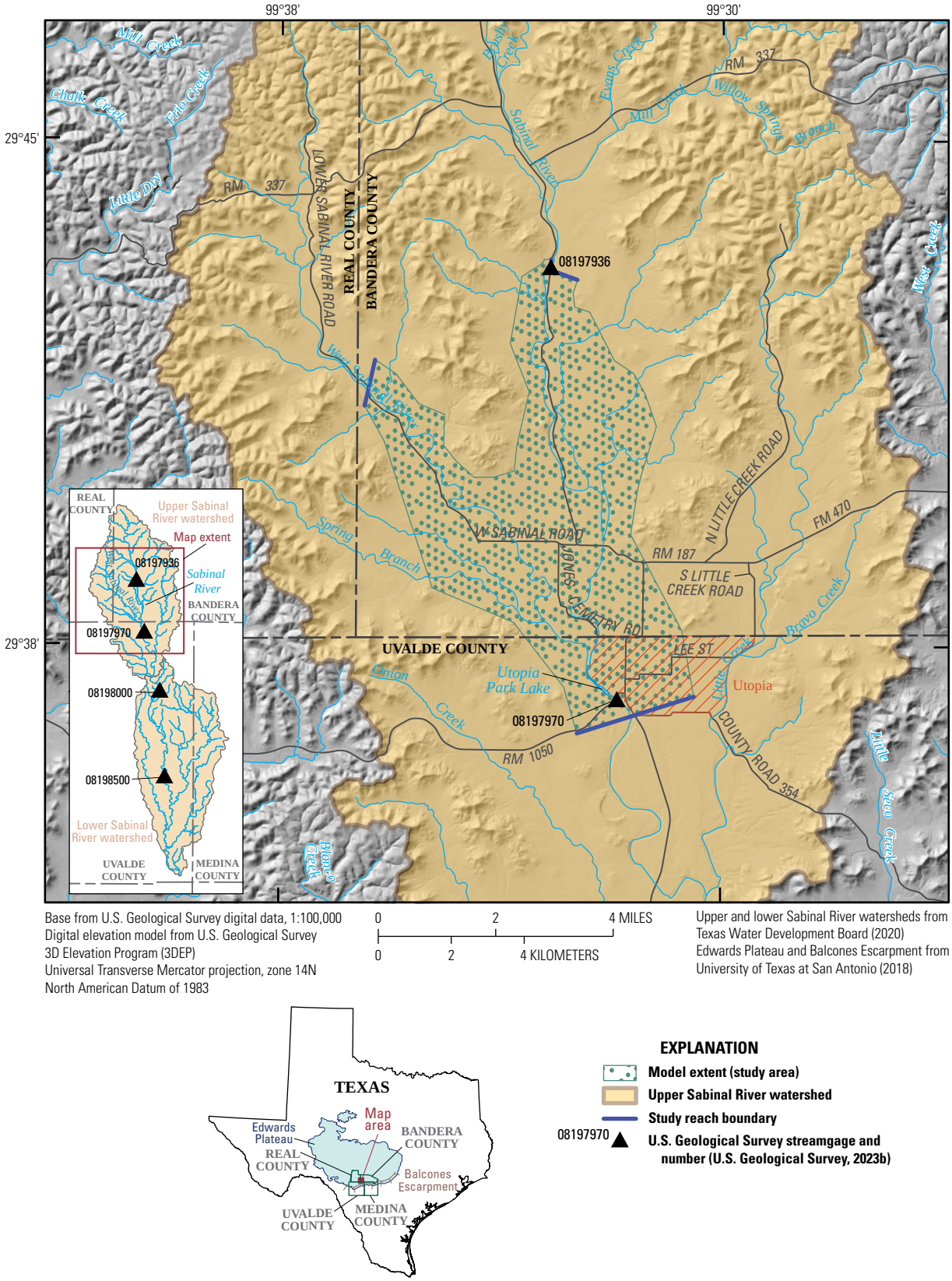

Figure 1. Location of the study area in central Texas, including the extent of the hydraulic model, the study reach on the Sabinal River and the West Sabinal River, and the nearest U.S. Geological Survey streamgages (modified from Choi [2023a]).

Figure 2. Continuous stream stage data are collected at the newly installed U.S. Geological Survey streamgage 08197970 Sabinal River at Utopia, Texas (photograph by Namjeong Choi, U.S. Geological Survey, February 26, 2020).

Flood-Inundation Communication

The library of flood-inundation maps is publicly available through the Interagency Flood Risk Management initiative's Flood Decision Support Toolbox website (https://webapps.usgs.gov/infrm/fdst/). This interactive online application provides detailed information on flood-inundation extents and water depths for various stream stages at select USGS streamgages. By subscribing to the USGS WaterAlert service (https://www.usgs.gov/tools/wateralert), users can also receive email or text (short message service [SMS]) alerts when selected streamgage measurements, such as stream stage or discharge, exceed user-definable thresholds.

The flood-inundation maps developed in this study, in conjunction with the real-time stage data from the Utopia gage, are intended to help guide the public in taking individual safety precautions and provide emergency management personnel with a toolset to efficiently manage emergency flood operations and postflood recovery efforts.

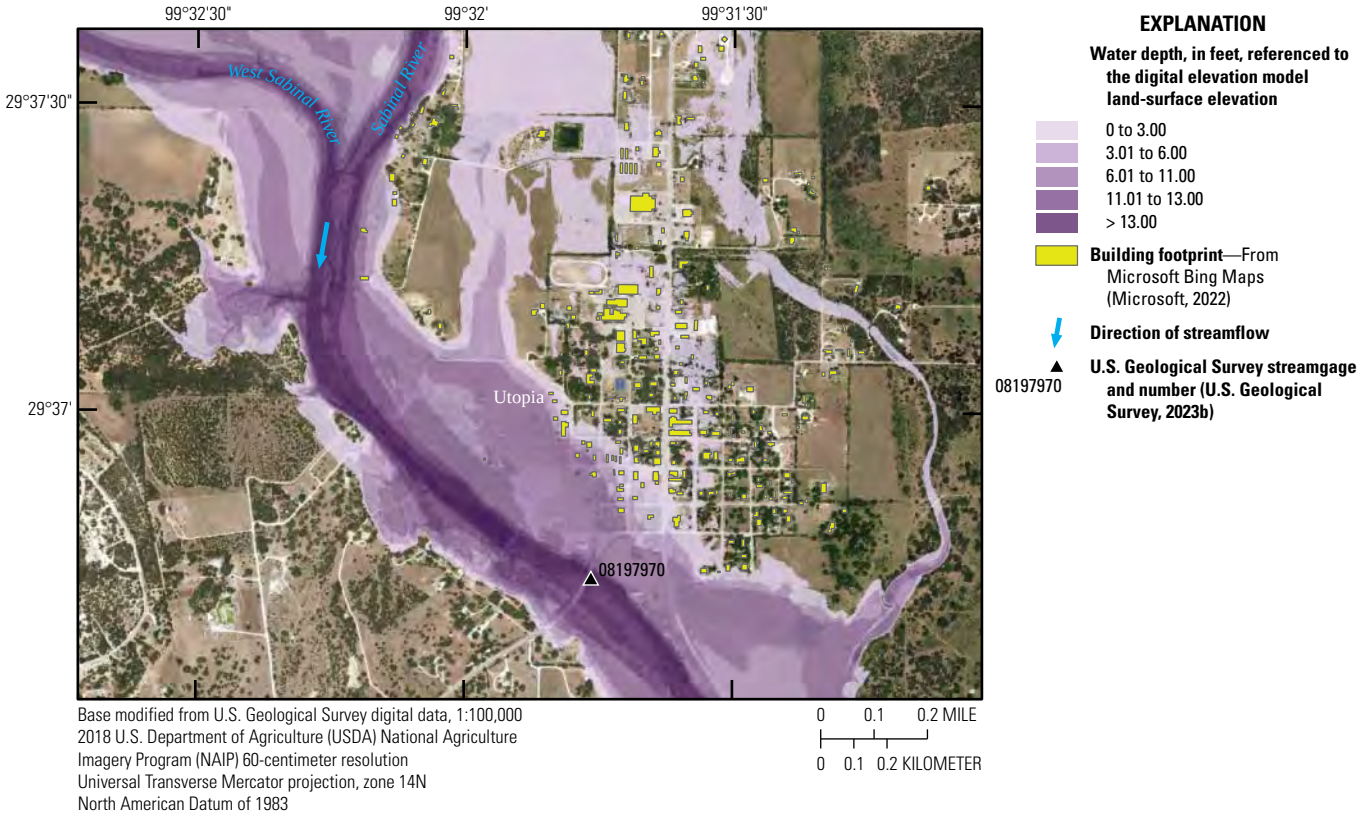

Figure 3. An example flood-inundation map showing flood extent and potential water depths of the Sabinal River at U.S. Geological Survey streamgage 08197970 Sabinal River at Utopia, Texas, for a simulated stream stage of 28 feet, which corresponds to the approximate peak stage observed on July 5, 2002, during the July 2002 flood event (modified from Choi [2023a]).

This Fact Sheet is based on the following publication:

Choi, N., 2023, Flood-inundation maps created using a synthetic rating curve for a 10-mile reach of the Sabinal River and a 7-mile reach of the West Sabinal River near Utopia, Texas, 2021 (ver. 2.0, September 2023): U.S. Geological Survey Scientific Investigations Report 2023–5001, 18 p., https://doi.org/10.3133/sir20235001.

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