Exceedance Probability Analysis for the San Antonio Area Rainfall Event of 23 - 24 May 2015

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Introduction

The Hydrometeorological Design Studies Center (HDSC) analyzed annual exceedance probabilities (AEPs) for a rainfall event that occurred in central Texas north of San Antonio on the night of 23 - 24 May 2015. AEP is probability of exceeding a given amount of rainfall for a given duration at least once in any given year at a given location. It is an indicator of the rarity of rainfall amounts and is used as the basis of hydrologic design.

For the AEP analysis, we look at a range of durations and select one or two critical durations that show the lowest exceedance probabilities for the largest area, i.e., the "worst case(s)." Since the beginning and ending of the worst case period is not necessarily the same for all locations, the AEP maps do not represent isohyets at any particular point in time, but rather within the whole event.

Underlying data

The underlying data for the AEP analyses are rainfall observations and point rainfall frequency estimates for a range of durations and frequencies.

Five-minute rainfall data used in this study, come from the KEWX Austin/San Antonio WSR88-D dual polarized radar level 3 data. The precipitation was aggregated to overlapping 3 and 6 hour durations, and the maximum amount of rainfall was extracted for each selected duration for each grid cell inside the area of interest.

We obtained gridded rainfall frequency estimates from the Weather Bureau's Technical Paper 40 - TP40 (Hershfield, 1961), which is still the valid NWS precipitation frequency document for the state of Texas. We first digitized paper cartographic maps from TP40 for 3-hour, 6-hour, and 24-hour durations and for 1/10, 1/50 and 1/100 AEPs (an example of a map from TP 40 is shown in Figure 1) and then used the standard spatial interpolation tools available in MATLAB to derive gridded estimates.

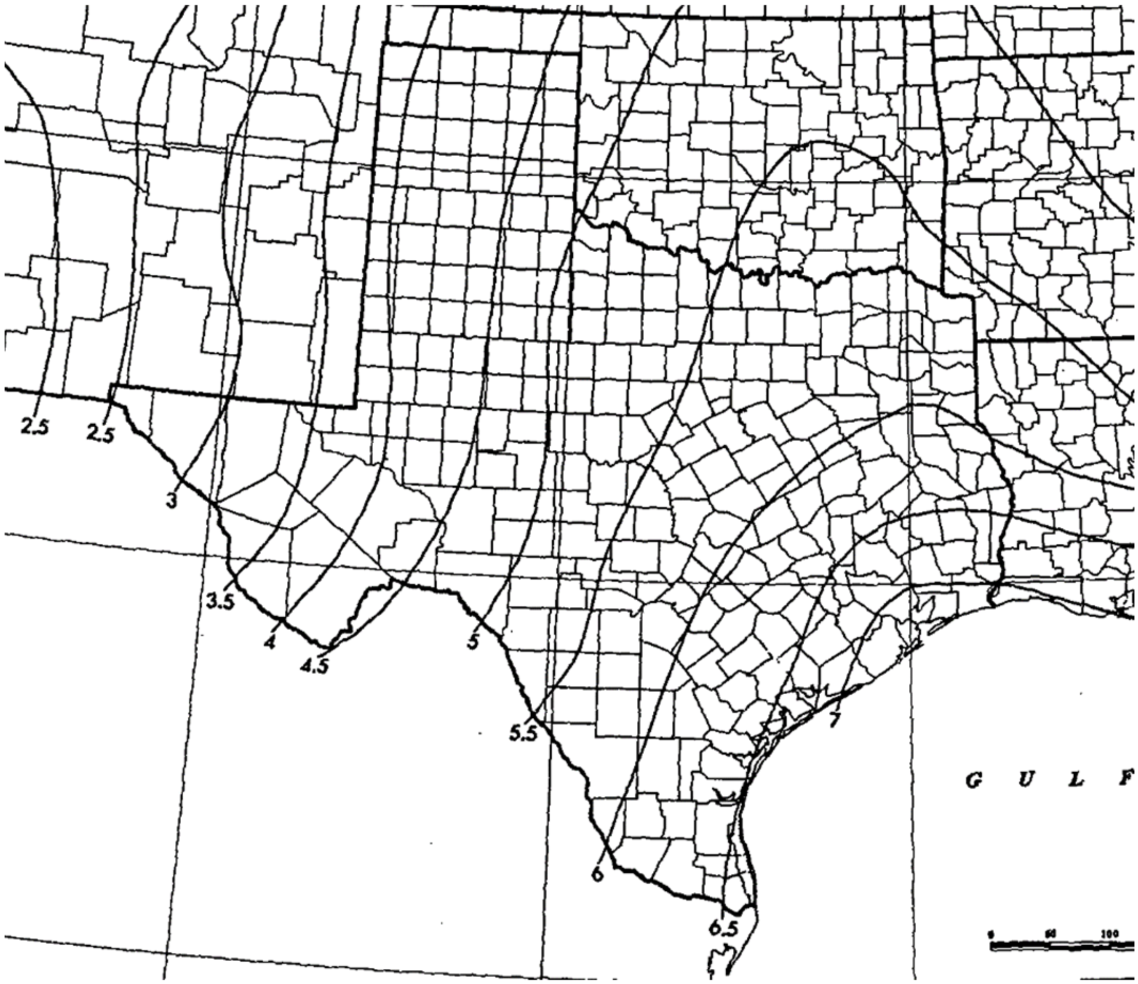

Figure 1. Cartographic map from TP40 showing precipitation frequency estimates for Texas for 3-hour duration and 1% AEP (100-year average recurrence interval).

Since the TP40 estimates are available only for selected AEPs up to the 1/100, we adopted simplified NOAA Atlas 14 methodology to extrapolate estimates to 1/200 and 1/500 AEP. We collected rain gauge data from the National Centers for Environmental Information's (NCEI) database for 13 stations in the region of interest and extracted annual maximum series (AMS) at 3 selected durations (3-hour, 6-hour, and 24-hour). From the AMS, we calculated regional L-moment statistics and then the parameters of the GEV distribution, which were used to produce precipitation frequency estimates for a range of durations and AEPs. For more information about regional frequency analysis, please see documentation for NOAA Atlas 14 Volume 9 (Perica et al., 2013). Extrapolation to 1/200 and 1/500 AEPs utilized the inherently strong linear relationship that was found to exist between precipitation frequency estimates for consecutive frequencies (R^2 value above 0.99). 1/200 AEP gridded estimates were obtained by applying the ratio of rainfall frequency estimates for 1/200 and 1/100 AEP from the GEV distribution to 1/100 AEP grid from the TP40. Similar method was applied to obtain 1/500 AEP gridded estimates.

Development of AEP grids

According to our data, rainfall amounts exceeded 9 to 11 inches in some areas, with a localized maximum of over 12 inches within 4-6 hours. This rainfall caused the Blanco river to rise rapidly downstream of the rainfall, such as at USGS site 08171350 Blanco River at San Marcos (Figure 2).

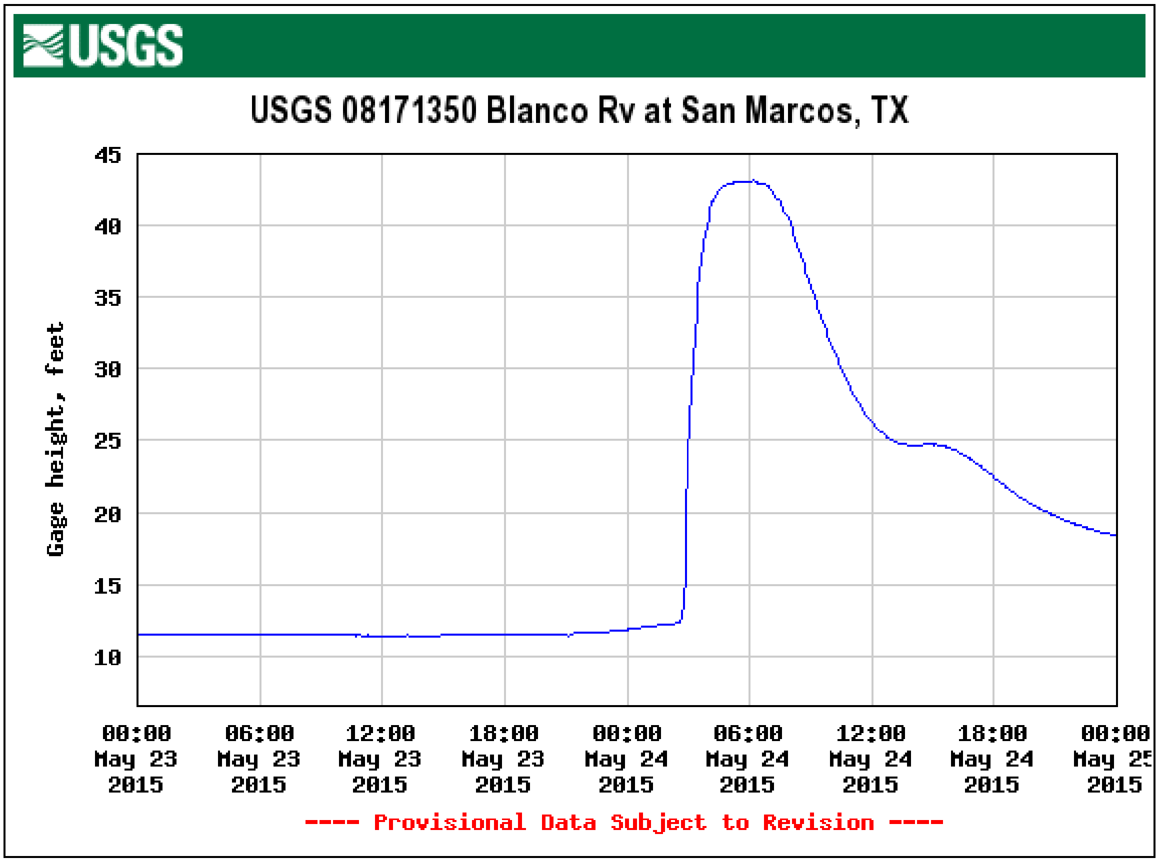

Figure 2. River gauge height at USGS site 08171350 Blanco River at San Marcos, Texas.

The maximum 3-hour and 6-hour precipitation grids were converted to AEP maps by comparing them to the TP40 grids (extrapolated to 1/500 AEP). The maps in Figures 3 and 4 show areas that experienced 3-hour and 6-hour rainfall magnitudes with AEPs ranging from 1/10 (10%) to smaller than 1/500 (0.2%).

References

Hershfield, D.M. (1961). Technical Paper No. 40, Rainfall Frequency Atlas of the United States for Durations from 30 Minutes to 24 Hours and Return Periods from 1 to 100 Years. U.S. Weather Bureau, Washington D.C.

Perica, S., D. Martin, S. Pavlovic, I. Roy, M. St. Laurent, C. Trypaluk, D. Unruh, M. Yekta, G. Bonnin (2013). NOAA Atlas 14 Volume 9 Version 2, Precipitation-Frequency Atlas of the United States, Southeastern States. NOAA, National Weather Service, Silver Spring, MD.

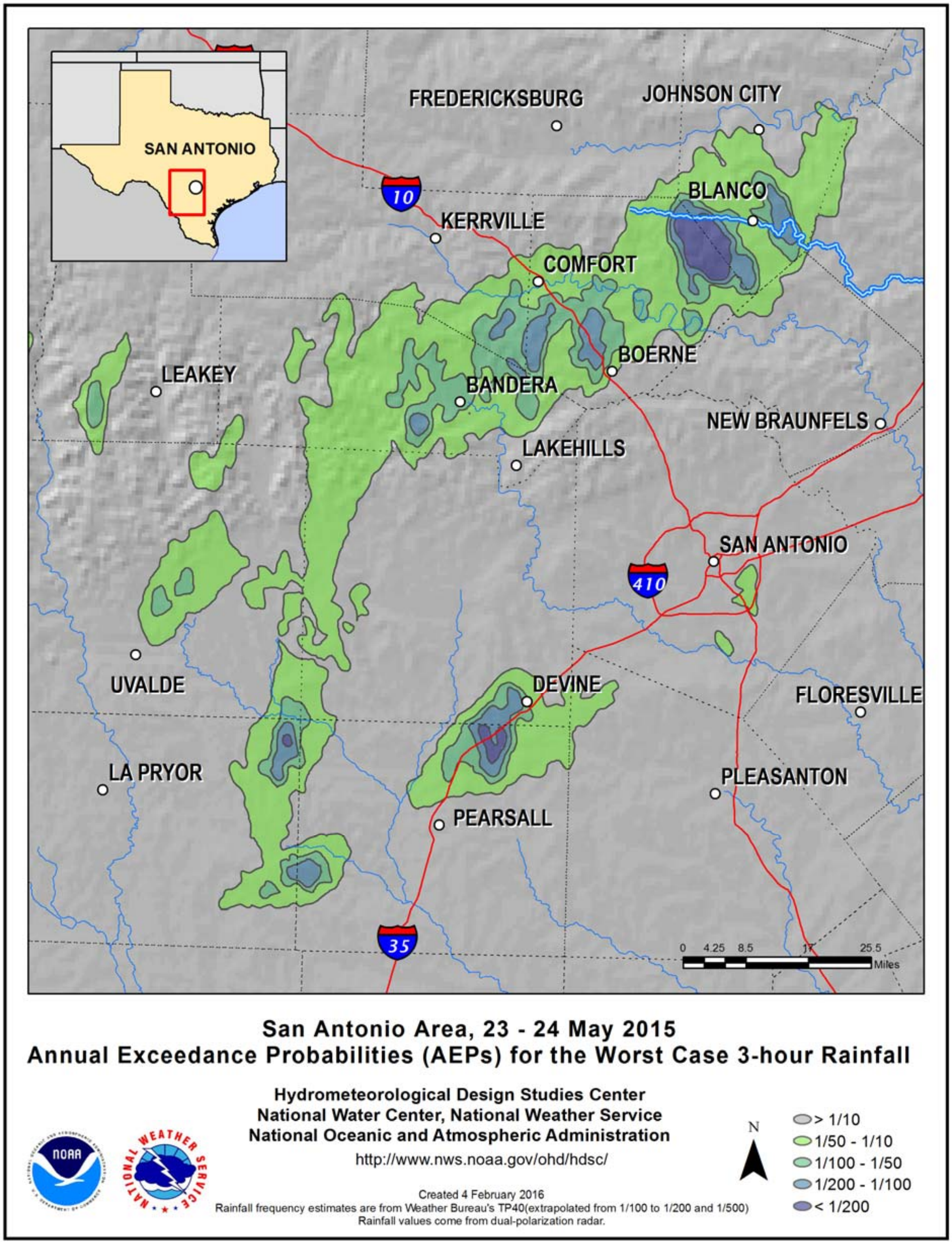

Figure 3. Annual exceedance probabilities for the worst case 3-hour rainfall from 23 to 24 May 2015.

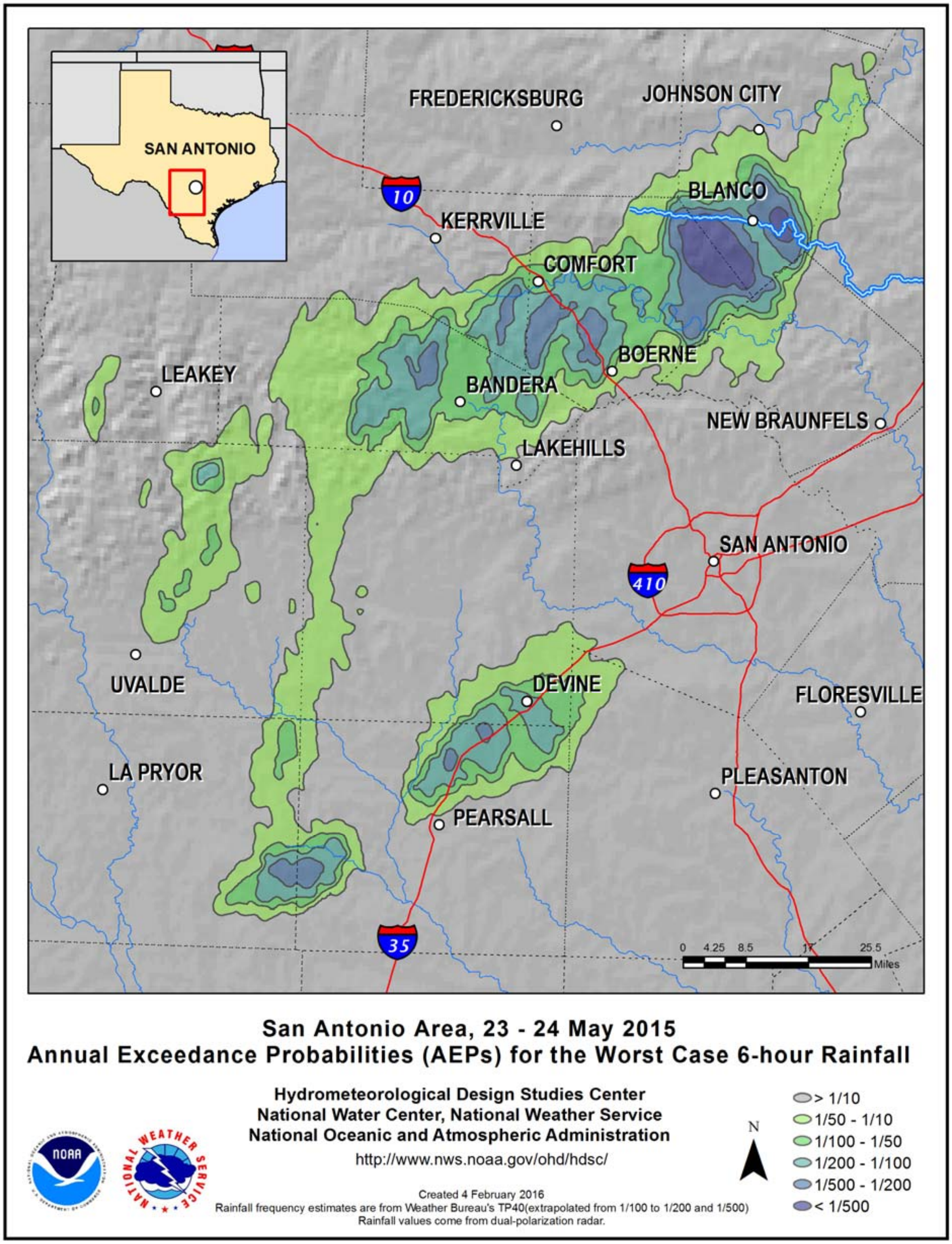

Figure 4. Annual exceedance probabilities for the worst case 6-hour rainfall from 23 to 24 May 2015.