Exceedance Probability Analysis for the Southeastern New England Rainfall Events of March 2010

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The Hydrometeorological Design Studies Center (HDSC) analyzed annual exceedance probabilities (AEPs) for the Southeastern New England rainfall events that occurred during March 2010. AEP is probability of exceeding a given amount of rainfall 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. Three rainfall events in the month of March delivered rainfall amounts that exceeded 20 inches in some locations. The runoff from the rainfall caused record river stages throughout Southeastern New England. Figure 1 shows river stage heights for the U. S. Geological Survey (USGS) stream site 01116500 at the Pawtuxet River in Cranston, Rhode Island. This site experienced two of its highest crests on record approximately two weeks apart: 14.98 ft on March 15th, and 20.79 ft on March 31st. The previous record was 14.50 ft on June 6th, 1982. This site has data back to 1939. A list of historic crests is available here.
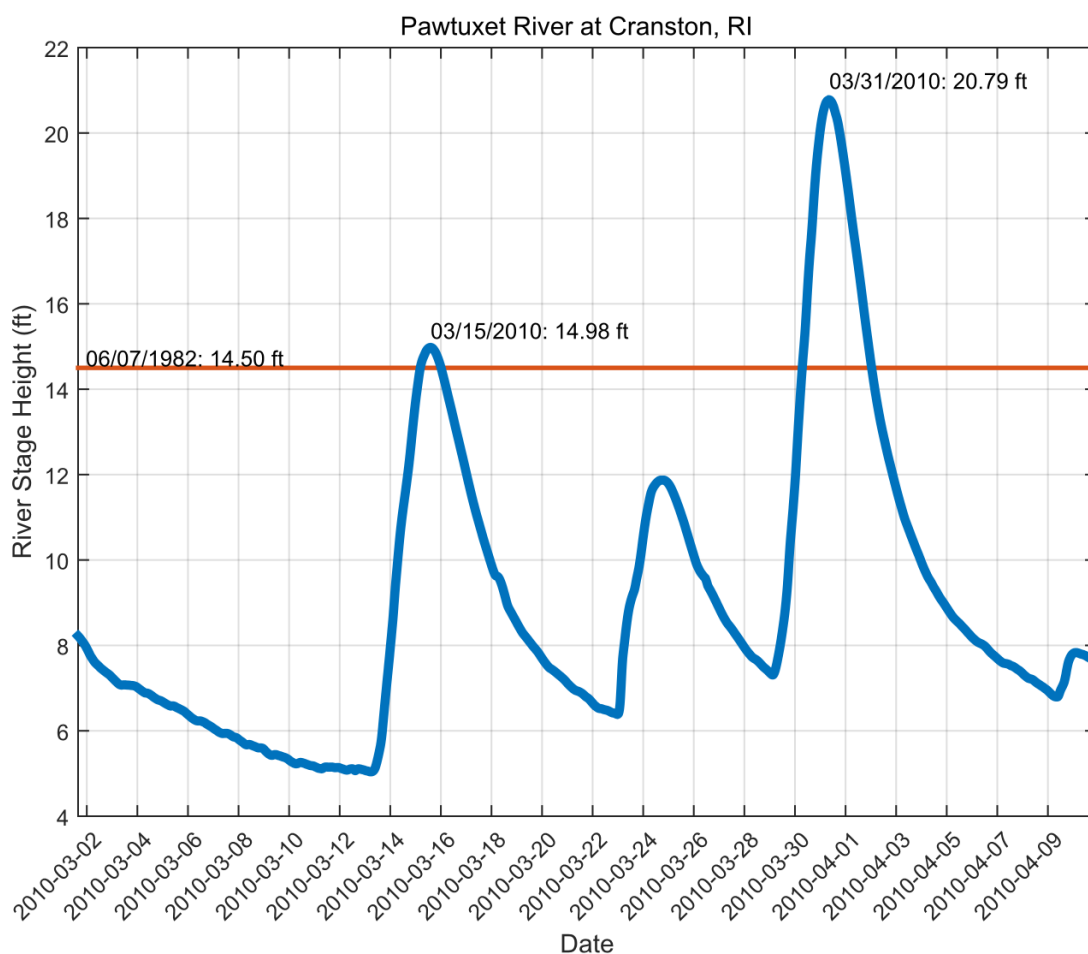

Figure 1. River stage heights at USGS stream site 01116500 at the Pawtuxet River in Cranston, RI. Two river crests in March 2010 broke the previous record.

The rarity of this event is illustrated in two figures below. Figure 2 shows how the maximum observed rainfall amounts compared to corresponding rainfall frequency estimates for AEPs from 1/2 (50%) to 1/1000 (0.1%) for durations from 1 day to 60 days for a rain gauge in Rhode Island - US1RIKN0001, Coventry Center (41.673°N, 71.617°W, 387 ft elevation). The rain gauge is part of the Community Collaborative Rain, Hail & Snow Network (CoCoRaHS). The AEPs are preliminary estimates from unpublished NOAA Atlas 14, Volume 10, and may differ from final estimates, which will be released in September 2015. The upper bound of the 90% confidence interval for 1/1000 AEP is also shown in the figure to illustrate uncertainty associated with the calculation of AEPs, which increase as the AEP becomes smaller. As can be seen from Figure 2, observed rainfall amounts have probabilities of less than 1/1000 for durations above 10-day. All rainfall amounts are below the upper bound of the 90% confidence interval of corresponding 1/1000 AEP estimates.
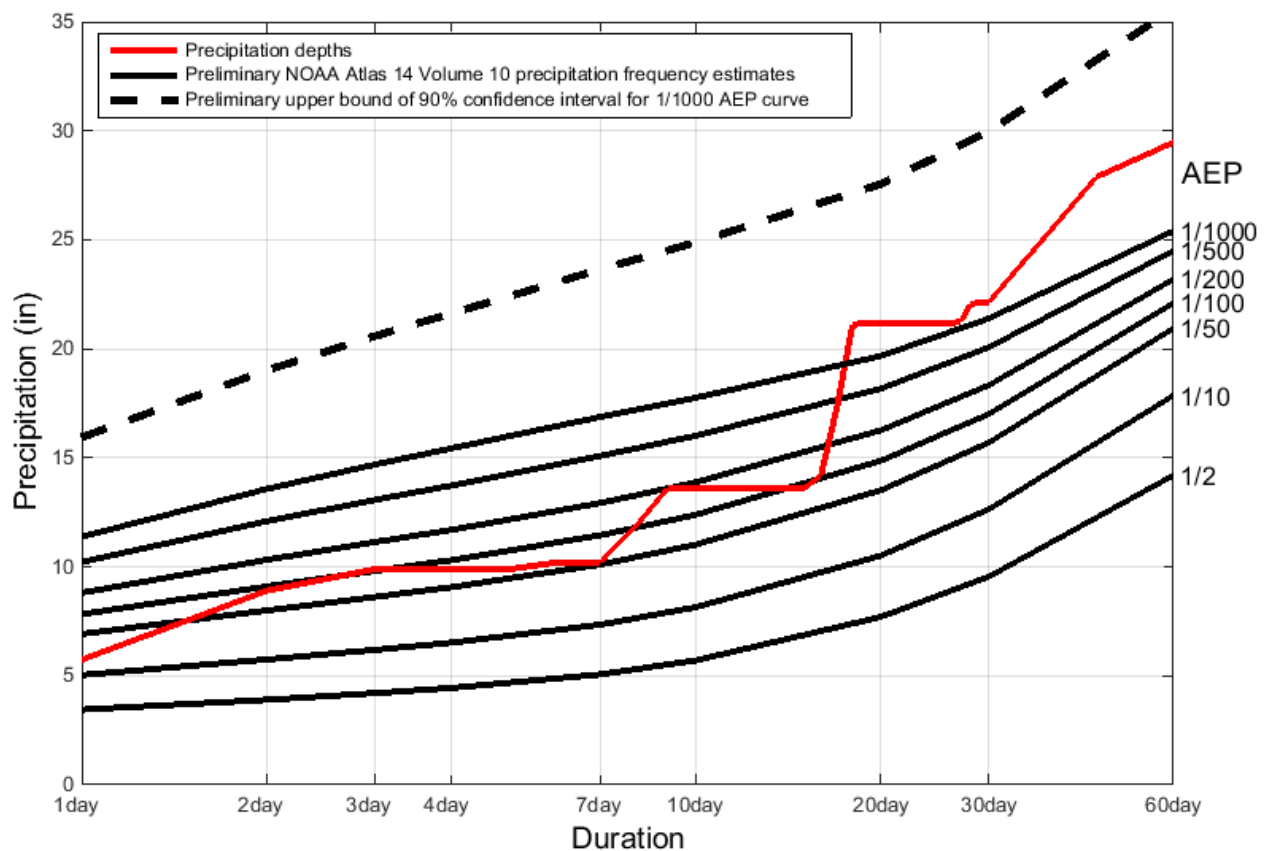

Figure 2. Maximum observed rainfall amounts in relationship to corresponding precipitation frequency estimates for the US1RIKN0001 gauge.

The map in Figure 3 shows the areas that experienced rainfall magnitudes with AEPs ranging from 1/10 (10%) to smaller than 1/1000 (0.1%) for the 20-day duration. Rainfall amounts are derived from rain gauge data from the Global Historical Climatology Network - Daily (GHCN-daily). Rainfall frequency estimates are preliminary estimates from the NOAA Atlas 14, Volume 10. The 20-day duration was selected because it showed the smallest AEPs for the largest area. Note that the beginning and ending of the worst case observation period is not necessarily the same for each location. As a result, this map does not represent isohyets at any particular point in time, but rather the whole event.
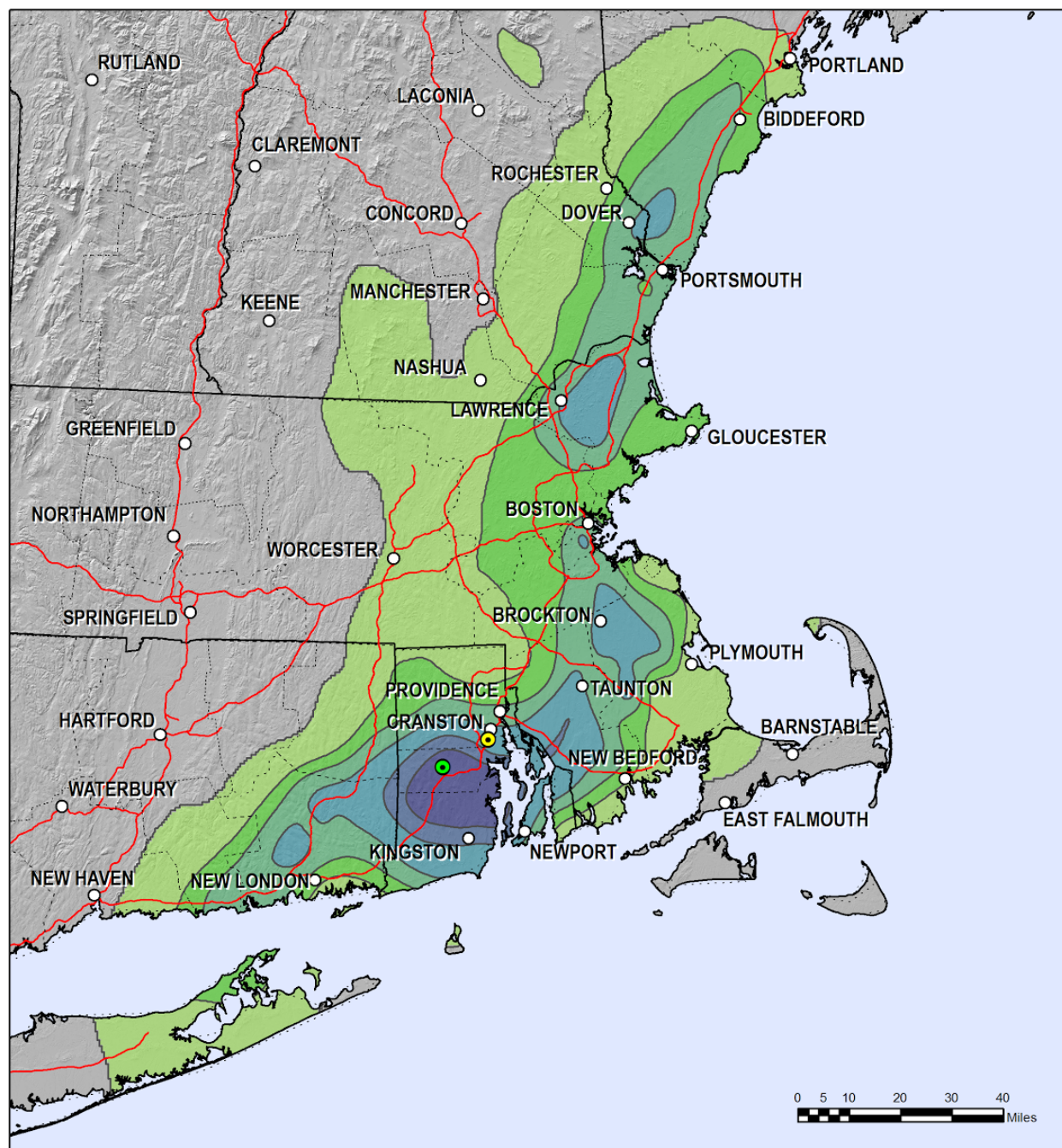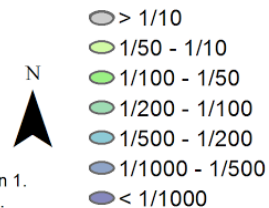
Figure 3. Annual exceedance probabilities for the worst case 20-day rainfall. The yellow marker is the location of the USGS 01116500 river gauge. The green marker is the location of the US1RIKN0001 CoCoRaHS gauge.