U.S. Geological Survey
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PROJECT SUMMARY REPORT

Project Summary Report 5–1301–01–S

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Atlas of Depth-Duration Frequency of Precipitation Annual Maxima for Texas

The objective of this Texas Department of Transportation (TxDOT) and U.S. Geological Survey (USGS) cooperatively funded project was to develop a simple-to-use atlas of precipitation depths in Texas for selected storm durations and frequencies on the basis of the research results and unpublished digital archives of Asquith (1998). The selected storm durations are 15 and 30 minutes; 1, 2, 3, 6, and 12 hours; and 1, 2, 3, 5, and 7 days. The selected storm frequencies or annual recurrence intervals are 2, 5, 10, 25, 50, 100, 250, and 500 years. Depth-duration frequency (DDF) of annual precipitation maxima is important for cost-effective, risk-mitigated hydrologic design. DDF values are in common and wide-spread use by public and private entities throughout Texas.

Asquith (1998) provides 37 maps and a table of parameters of probability distributions that model DDF of precipitation in Texas; Asquith (1998) also provides procedures or guidance for parameter map use. TxDOT and the USGS cooperatively funded a research study in the mid-1990s to update DDF values for Texas. However, an unanticipated (by both TxDOT and USGS personnel in the mid-1990s) consequence of the Asquith (1998) presentation format is that many design engineers have had greater-than-expected difficulty implementing the procedures. Therefore, to simplify implementation of the procedures of Asquith (1998), this project, during 2003–04, produced an atlas of 96 maps of precipitation depth for the selected storm durations and frequencies. The results of this project ("the atlas") are documented in Strand (2003) and Asquith and Roussel (2004). The atlas is based on Asquith (1998) and on a large National Weather Service (NWS) precipitation database, is underlain by state-of-the-practice L-moment statistics and distributional theory, and most importantly, is simple to use. This summary report briefly recounts what was done and what was found, and provides additional notes regarding use of the atlas.

What We Did...

The objective of the project was to develop a simple-to-use atlas of

precipitation depths in Texas for selected values of DDF on the basis of the Asquith (1998) research results and unpublished digital archives. To complete the objective, numerous checks for "internal consistency" of the DDF maps were required; consistency means that the precipitation depth for a given frequency (or duration) monotonically increases with storm duration (or frequency). Consistency also implies that DDF values are similar in magnitude at the Texas and Oklahoma border to those from a recent DDF atlas for Oklahoma (Tortorelli and others, 1999). In the course of the consistency check, uncertainty in depth-duration values for large recurrence-interval 1-day and less durations in a part of South Texas and in the Wichita Falls, Texas, area was explored through analysis of NWS precipitation data and reinterpretation of Asquith (1998) and Tortorelli and others (1999) results. After these checks were completed, through the use of a geographical information system and manual verification, contour maps were developed for each duration and for each recurrence interval. Intermediate digital raster datasets were constructed from the Asquith (1998) parameter maps and were used to construct the contour maps. The contour maps subsequently required minor and localized adjustment and smoothing of contour lines for consistency. Both Strand (2003) and in particular Asquith and Roussel (2004) describe in detail the analysis used for the project.

What We Found...

1. In general, the intermediate raster datasets of precipitation depth generated from Asquith (1998) parameter maps were consistent. Furthermore, in areas of Texas with precipitation inconsistencies, the inconsistencies were small relative to the potential error and uncertainty associated with precipitation frequency analysis in general and Asquith (1998) DDF maps in particular.

2. DDF of precipitation for regions of substantial inconsistency were readily corrected through minor contour-line adjustment and new statistical regionalization of NWS data or re-interpretation of Asquith (1998) and Tortorelli and others (1999).

3. The DDF maps depicted in Asquith and Roussel (2004) present the "final" contour lines for the project. Numerous tick marks are on the maps to facilitate digital representation by users of the atlas. All existing geographic information system maps or files at the close of the project are considered intermediate, unpublished archives.

4. The transition from the generalized logistic distribution to the generalized extreme-value distribution at the 1-day duration contributes to interpretation and consistency difficulties. Asquith (1998, p. 24) elaborates and refers to consistency problems as "discrepancies." However, the authors subsequently observed that the change in probability distribution contributed only moderately to now-corrected inconsistencies.

5. Following approximately 7 years of perspective and nearly 750 copies of the report in the hands of public agencies, universities, and private entities, and after 2 years of analysis as part of this project, the results of Asquith (1998) are fundamentally sound. However, the authors expect that differences in DDF values derived from Asquith (1998) and Asquith and Roussel (2004) could result. The results of Asquith and Roussel (2004) are considered preferable.

Notes Regarding Use of the Atlas...

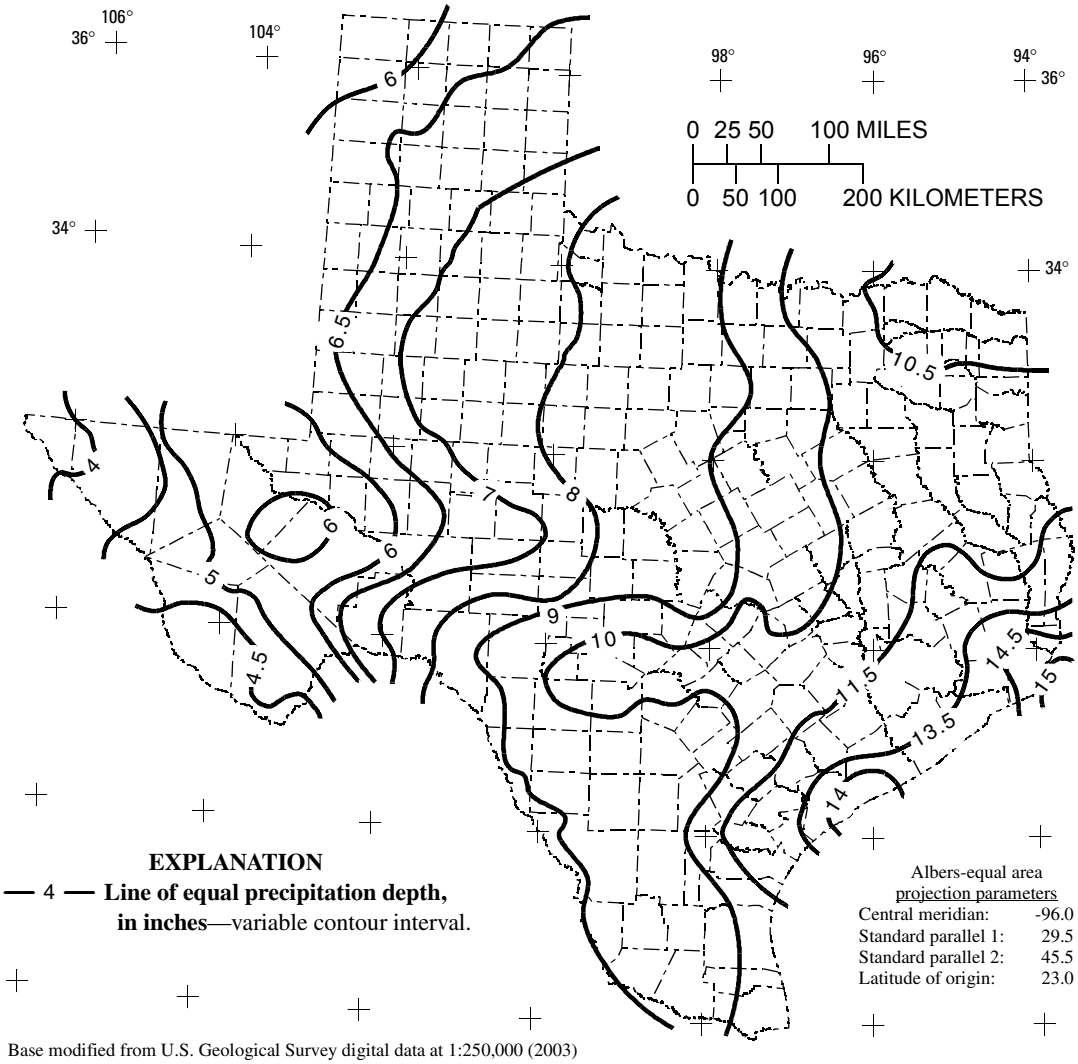
1. Asquith and Roussel (2004) can be used to

estimate the DDF curve for any location in Texas for engineering designs or other purposes requiring storm magnitude risk (see figure for an example map).

2. Dividing the DDF curve by storm duration produces an intensity-duration frequency (IDF) curve. Several well-known hydrologic engineering practices require an IDF curve.

3. The atlas supersedes previous DDF values from sources such as Hershfield (1962), Miller (1964), and Frederick and others (1977) because considerably more data was processed, state-of-the-practice statistical techniques were used, and greater spatial resolution was possible.

4. The atlas might be preferable to locality-specific DDF or IDF studies because of the statewide scope of the analysis leading to the maps in Asquith and Roussel (2004).



Depth of the 1-day 100-year storm in Texas produced by the project.

For More Information...

More information about the results and context of this project, the underlying statistical methods, or other Texas-specific precipitation magnitude studies can be found in the following references:

Asquith, W.H., 1998, Depth-duration frequency of precipitation for Texas: U.S. Geological Survey Water-Resources Investigations Report 98–4044, 107 p.

Asquith, W.H., and Roussel, M.C., 2004, Atlas of depth-duration frequency of precipitation annual maxima for Texas: U.S. Geological Survey Scientific Investigations Report 2004–5041, 106 p.

Frederick, R.H., Meyers, V.A., and Auciello, E.P., 1977, Five- to 60-minute precipitation frequency for the eastern and central United States: Silver Springs, Md., U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Weather Service, NOAA Technical Memorandum NWS HYDRO–35, 36 p.

Hershfield, D.M., 1962, Rainfall frequency atlas of the United States for durations from 30 minutes to 24 hours and return periods from 1 to 100 years: Washington, D.C., U.S. Weather Bureau Technical Paper 40, 61 p.

Lanning-Rush, Jennifer, Asquith, W.H., and Slade, R.M., 1998, Extreme precipitation depths for Texas, excluding the Trans-Pecos region: U.S. Geological Survey Water-Resources Investigations Report 98–4099, 38 p.

Miller, J.F., 1964, Two- to ten-day precipitation for return periods of 2 to 100 years in the contiguous United States: Washington, D.C., U.S. Weather Bureau Technical Paper 49, 29 p.

Strand, M.C., 2003, Depth-duration frequency of precipitation annual maxima in Texas: Austin, Texas, The University of Texas at Austin, M.S. thesis, 195 p.

Tortorelli, R.L., Rea, Alan, and Asquith, W.H., 1999, Depth-duration frequency of precipitation for Oklahoma: U.S. Geological Survey Water-Resources Investigations Report 99–4232, 113 p.

TxDOT Implementation Status

Many TxDOT Design engineers have had greater-than-expected difficulty implementing the procedures applying the updated precipitation data established by a research project completed in the 1990s and cooperatively funded by TxDOT and the USGS. The difficulty has delayed the implementation of the new precipitation data. The purpose of Project 5–1301–01 was to develop a simple-to-use atlas of the updated precipitation depths in Texas for selected values of storm duration and frequency. This project produced an atlas of 96 maps. The new maps will be made available online or in a future revision of the Hydraulic Design Manual.

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Also see Report 5–1301–01–1, "Atlas of Depth-Duration Frequency of Precipitation Annual Maxima for Texas." This report includes the atlas consisting of 96 maps and is available from the Center for Transportation Research Library, (512) 232–3126, or e-mail ctrlib@uts.cc.utexas.edu.

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