

RAINFALL INTENSITY IN DESIGN

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ABSTRACT

An empirical, dimensionless-hyetrograph that relates depth and duration, and thus whether a storm is front loaded, back loaded, or uniformly loaded, based on 92 gaging stations for storms known to have produced runoff is available for Texas. Statistical characteristics of storm interevent time, depth, and duration, based on analysis of hourly rainfall data for 533 rain gages are used to "dimensionalize" this hyetrograph and produce a set of simulated storms.

These simulated storms are analyzed to generate a set of rainfall intensities, and these intensities are compared to global maximum observed rainfall, intensities estimated using the National Weather Service TP-40, and HY-35 publications, and a current Texas Department of Transportation design equation.

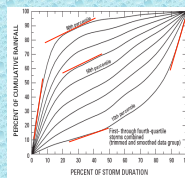
The simulated storms agree well with the other methods for rare (i.e. 90-th percentile and above) occurrences and lie within the global maxima envelope. The simulated results are quite different for common (i.e. 50-th percentile) events.

INTRODUCTION

The work presented is the result of a question (see acknowledgements) "How hard can it rain?" Rainfall intensity has a variety of practical uses: BMP design, detention design, rational runoff rates, and so forth.

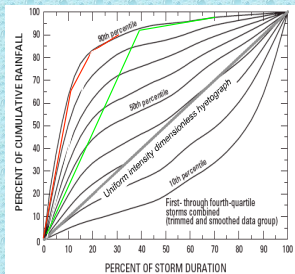
DATA SOURCES:

The following sources constitute the database discussed in this poster: Asquith and others (2006), Asquith and others (2004), Williams-Sether and others (2004), Smith and others (2001), Barcelo and others (1997), Paulhus (1965), Jennings (1950)



DIMENSIONLESS HYETROGRAPH

Slopes are dimensionless intensity



INTENSITY SIMULATION (DIMENSIONLESS)

Use different portions of dimensionless hyetrograph; simulate many different intensities, then sort and rank.

EMPIRICAL HYETROGRAPHS

Sether-Williams and others (2004) analyzed 92 stations, 1507 storms, known to have produced runoff. Each storm duration was divided into 4-quartiles. The quartile with largest accumulation of rainfall defines "storm quartile."

The observed rainfall collected into 2.5-percentile "bins" and smoothed to force monotonic dimensionless hyetrographs. Result is empirical-dimensionless-hyetrograph.

Subsequent to that report, the authors noted that the slopes of these hyetrographs are dimensionless "intensity". Used that concept to generate various collections of dimensionless intensity, but need a way to dimensionalize for comparison to actual data or for practical application.

INTENSITY SIMULATION

Asquith and others (2006), analyzed 774 stations in New Mexico, Oklahoma, and Texas. Generated depth quantiles for each "storm." (Half-Minimum). The computed L-moments for each station for duration and depth. Studied various distributions, ultimately recommended a Kappa distribution as most appropriate distribution for depth and duration.

They provided "tools" to parameterize the empirical-dimensionless-hyetrographs.

Page 42 explains how to use Kappa quantile function and L-moments to recover storm depth (vertical axis of dimensionless hyetrograph).

Page 43 explains how to use Kappa quantile function and L-moments to recover duration (horizontal axis of the empirical hyetrograph).

However, at the time they did not provide the "code" to access the tools (except by reference).

Example 13: The mean flow for the 95th percentile storm is about 1.5 cfs per acre (1.1). To further illustrate the application of the report, from the empirical-dimensionless-hyetrograph for the 95th percentile storm (0.15, 0.2, 0.25, 0.3, 0.35, 0.4, 0.45, 0.5, 0.55, 0.6, 0.65, 0.7, 0.75, 0.8, 0.85, 0.9, 0.95, 1.0) and the mean flow for the 50th percentile storm (0.1, 0.15, 0.2, 0.25, 0.3, 0.35, 0.4, 0.45, 0.5, 0.55, 0.6, 0.65, 0.7, 0.75, 0.8, 0.85, 0.9, 0.95, 1.0) and the mean flow for the 10th percentile storm (0.05, 0.07, 0.1, 0.13, 0.17, 0.22, 0.28, 0.35, 0.43, 0.52, 0.62, 0.73, 0.85, 0.98, 1.1, 1.3, 1.5, 1.7, 2.0, 2.3, 2.6, 3.0, 3.4, 3.8, 4.3, 4.8, 5.4, 6.0, 6.7, 7.4, 8.1, 8.9, 9.7, 10.6, 11.6, 12.7, 13.9, 15.2, 16.6, 18.1, 19.7, 21.4, 23.2, 25.1, 27.1, 29.2, 31.4, 33.7, 36.1, 38.6, 41.2, 43.9, 46.7, 49.6, 52.6, 55.7, 58.9, 62.2, 65.6, 69.1, 72.7, 76.4, 80.2, 84.1, 88.1, 92.2, 96.4, 100.7, 105.1, 109.6, 114.2, 118.9, 123.7, 128.6, 133.6, 138.7, 143.9, 149.2, 154.6, 160.1, 165.7, 171.4, 177.2, 183.1, 189.1, 195.2, 201.4, 207.7, 214.1, 220.6, 227.2, 233.9, 240.7, 247.6, 254.6, 261.7, 268.9, 276.2, 283.6, 291.1, 298.7, 306.4, 314.2, 322.1, 330.1, 338.2, 346.4, 354.7, 363.1, 371.6, 380.2, 388.9, 397.7, 406.6, 415.6, 424.7, 433.9, 443.2, 452.6, 462.1, 471.7, 481.4, 491.2, 501.1, 511.1, 521.1, 531.2, 541.4, 551.7, 562.1, 572.6, 583.2, 593.9, 604.7, 615.6, 626.6, 637.7, 648.9, 660.2, 671.6, 683.1, 694.7, 706.4, 718.2, 730.1, 742.1, 754.2, 766.4, 778.7, 791.1, 803.6, 816.2, 828.9, 841.7, 854.6, 867.6, 880.7, 893.9, 907.2, 920.6, 934.1, 947.7, 961.4, 975.2, 989.1, 1003.1, 1017.2, 1031.4, 1045.7, 1060.1, 1074.6, 1089.2, 1103.9, 1118.7, 1133.6, 1148.6, 1163.7, 1178.9, 1194.2, 1209.6, 1225.1, 1240.7, 1256.4, 1272.2, 1288.1, 1304.1, 1320.2, 1336.4, 1352.7, 1369.1, 1385.6, 1402.2, 1418.9, 1435.7, 1452.6, 1469.6, 1486.7, 1503.9, 1521.2, 1538.6, 1556.1, 1573.7, 1591.4, 1609.2, 1627.1, 1645.1, 1663.2, 1681.4, 1700.7, 1719.1, 1737.6, 1756.2, 1774.9, 1793.7, 1812.6, 1831.6, 1850.7, 1870.0, 1889.4, 1908.9, 1928.5, 1948.2, 1968.0, 1987.9, 2007.9, 2028.0, 2048.2, 2068.5, 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5472.2, 5505.9, 5539.7, 5573.6, 5607.6, 5641.7, 5675.9, 5710.2, 5744.6, 5779.1, 5813.7, 5848.4, 5883.2, 5918.1, 5953.1, 5988.2, 6023.4, 6058.7, 6094.1, 6129.6, 6165.2, 6200.9, 6236.7, 6272.6, 6308.6, 6344.7, 6380.9, 6417.2, 6453.6, 6490.1, 6526.7, 6563.4, 6600.2, 6637.1, 6674.1, 6711.2, 6748.4, 6785.7, 6823.1, 6860.6, 6898.2, 6935.9, 6973.7, 7011.6, 7049.6, 7087.7, 7125.9, 7164.2, 7202.6, 7241.1, 7279.7, 7318.4, 7357.2, 7396.1, 7435.1, 7474.2, 7513.4, 7552.7, 7592.1, 7631.6, 7671.2, 7710.9, 7750.7, 7790.6, 7830.6, 7870.7, 7910.9, 7951.2, 7991.6, 8032.1, 8072.7, 8113.4, 8154.2, 8195.1, 8236.1, 8277.2, 8318.4, 8359.7, 8401.1, 8442.6, 8484.2, 8525.9, 8567.7, 8609.6, 8651.6, 8693.7, 8735.8, 8778.0, 8820.3, 8862.7, 8905.2, 8947.8, 8990.4, 9033.1, 9075.9, 9118.8, 9161.8, 9204.9, 9248.1, 9291.4, 9334.8, 9378.3, 9421.9, 9465.6, 9509.4, 9553.3, 9597.3, 9641.4, 9685.6, 9729.9, 9774.3, 9818.8, 9863.4, 9908.1, 9952.9, 9997.8, 10042.8, 10087.9, 10133.1, 10178.4, 10223.8, 10269.3, 10314.9, 10360.6, 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