Reanalysis of the Depth-Area Ratios in the Walnut Gulch Experimental Watershed

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Background
- Storm water engineers use depth-area (DA) ratios to design storm water infrastructure including bridges & culverts
- NOAA Atlas 2 developed DA ratios for continental United States in 1973 (Miller et al.)
- Osborn et al. (1980) studied regional DA with 20 years of data from the ARS Walnut Gulch Experimental Watershed.

Objectives
Main questions to be answered:
- Have point-duration frequencies changed with 62 years of observations (42 more than Osborn et al. used)?
- Can DAs from Osborn be reproduced?
- Do the depth-area ratios change with a greater number of rain gauges?

Methods
- Select a closely-spaced group of gauges.
- Find annual maximum rainfall of each rain gauge and the average of the group.
- Fit the Gumbel Dist. of the Fischer-Tippet Type 1 to each gauge & groups of gauges.
- Calculate the frequency for each gauge and group for 2-, 10-, 100-year returns.
- Take the ratio of the individual gages and the groups of gauges. (Weather Bureau, 1958)
- Apply the least-squares method fitting to the depth-area ratios (Osborn et al.,1980).

Data
Walnut Gulch Experimental Watershed Digital Rain Gauge Network 1957 - 2018

Discussion
- Individual frequency distributions have increased for the 2-year return interval and decreased for the 10- and 100-year returns from the 1980 analysis.
- Heavier precipitation occurred across the watershed in the 1980s compared to previous two decades.
- Re-creation of the 20-year analysis did not match the Osborn et al. (1980) curves for the 30-, 120- and 360-minute durations. In the new analysis, annual maximums were obtained by sliding windows of each duration at 1-minute increments, with missing data interpolated at each minute using multiquadric-biharmonic interpolation of the operational gauge set. In an effort to resolve the discrepancies, annual maximums were recomputed using data products that were known to exist in 1980, namely the daily and event maximums. However, both results were closer to the new results than those of Osborn et al. (1980).
- Depth-area ratios have increased for longer duration storms and with increased years of observations.

Future Research
- A new approach to computing depth-area ratios will be explored based on the spatial characteristics of individual storms rather than annual maximums. Maximum intensities at a point and averaged over increasing areas within a storm will be statistically analyzed in the context of return period. The results will be similar but more physically-based than the annual maximum approach, which is disassociated from individual storms.

Contact Information and Cited References

Figure 1: Walnut Gulch Experimental Watershed location in the Southeastern Arizona with the identified groups of rain gauges.

Figures 2-5: Depth-area ratio curves for the Walnut Gulch Experimental Watershed.