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Radar Analysis for Design Storm Application

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Research Objectives

Develop a design storm that is more representative of rainfall in Nevada for drainage infrastructure design

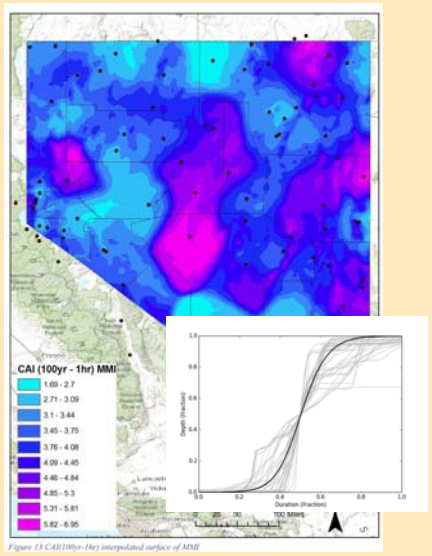
Nevada Department of Tranportation

Goals-

1. Develop representative temporal distributions called a hyetograph
2. Develop point-to-area relationships for applying rainfall depths of specific return interval, called a Depth-area-reduction-factor (DARF)

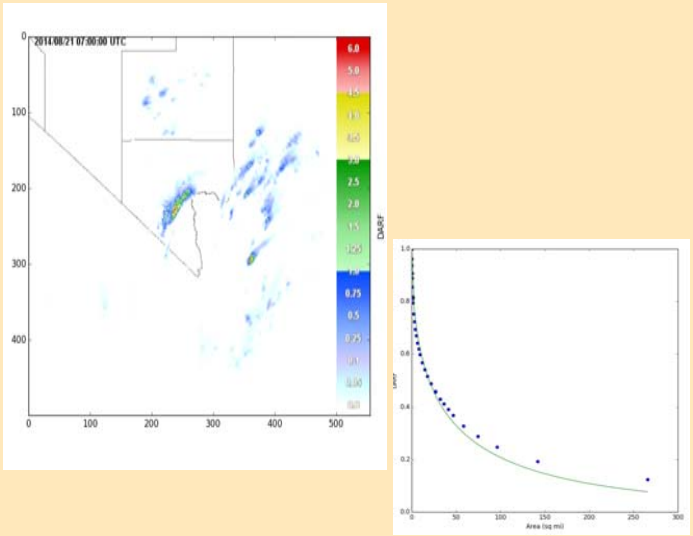
Research Components

1. Hyetograph (design storm distribution)



Temporal Synthesis

2. Depth-area-reduction-factor (DARF)



Areal Synthesis

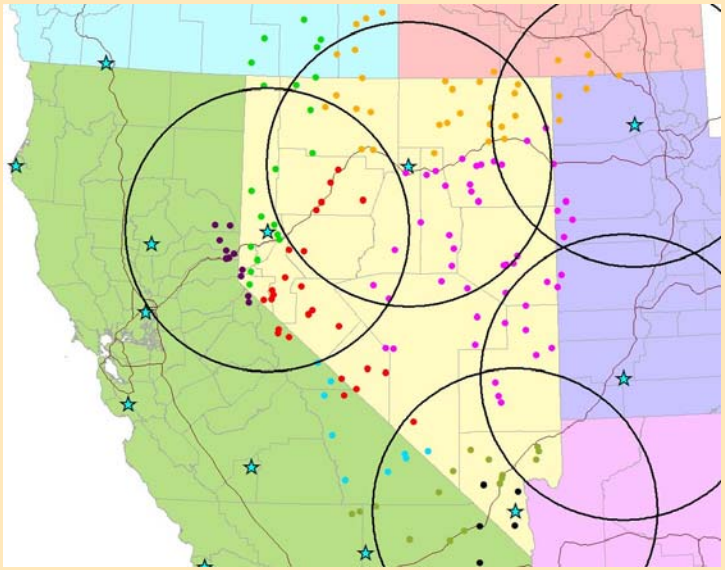
Methodology

1. Establish radar-based storm event list
2. Convert reflectivity to rainfall
3. Aggregate storm to specific durations
4. Develop depth-area-duration (DAD) values and select for maximum depth
5. Develop 50th and 90th DARF relationships
6. Compare results to historical studies in western US
7. Recommend 50th or 90th DARF based on hydrologic evaluation for use statewide

WSR-88D Stations

Radar Stations and Data
(2005 – 2014)

- KRGX (Reno, NV)
- KLRX (Elko, NV)
- KESX (Las Vegas, NV)
- KICX (Cedar City, UT)

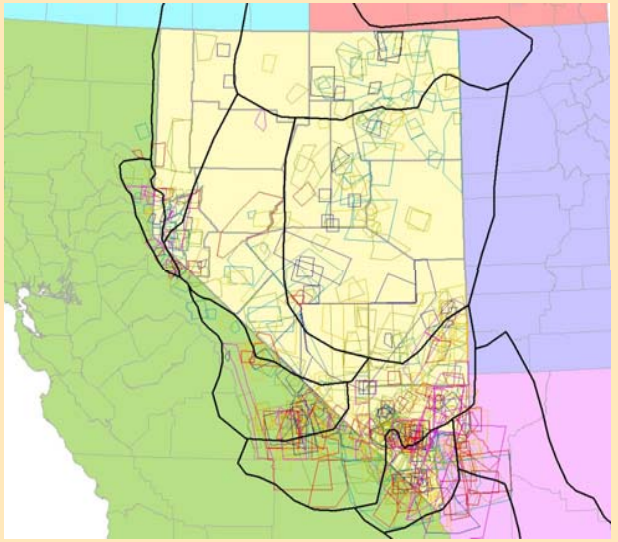


Storm Event Selection

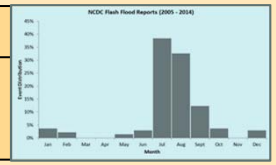
Seasonal Distribution

Events identified fron NWS flash flood warning or flood advisory (NCDC 2005-2014)

- 138 flash flood reports within HHAs 1-8
- Convective storms during the peak NAM months, with 83% falling in July–September.



HHA	1	2	3	4	5	6	7	8	Total
No. of Events	39	48	36	42	103	34	144	101	547

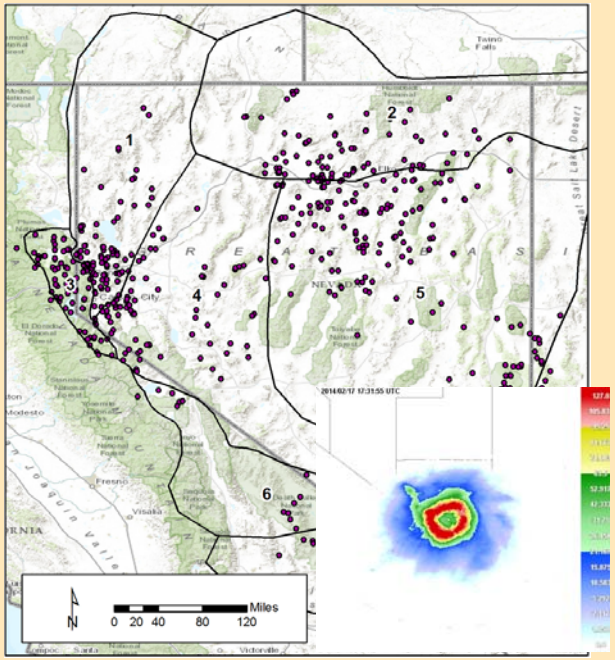


Distribution of Duration-Based Storm Events

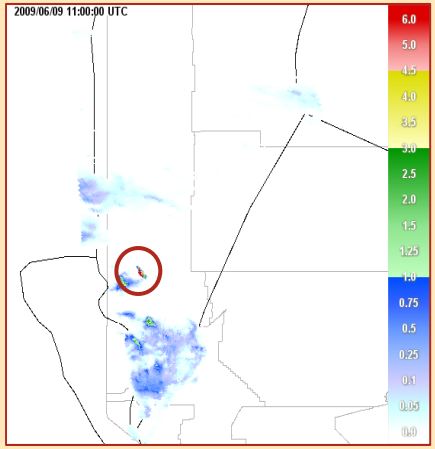
- Events in each of 8 Hydrometeorologically Homogeneous Areas (HHAs) targeted
- Radar reflectivity (Z) data converted to rainfall (R) using a putative relationship

$$Z=300R^{1.4}$$

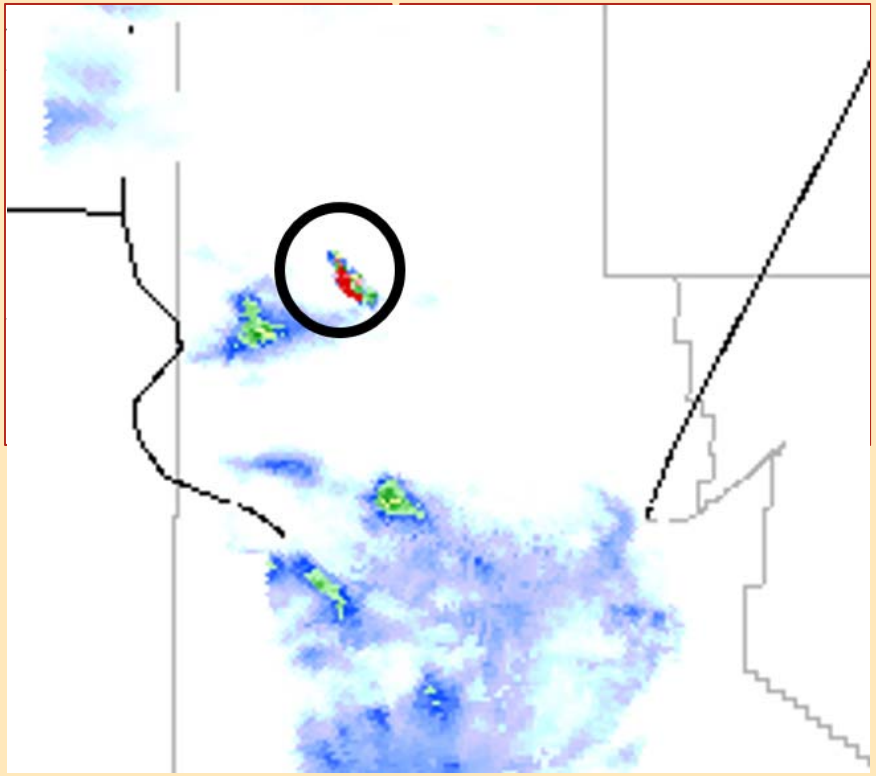
- Resulting (unadjusted) rainfall used to compute relative depths for point/area ratios
- Exclude radar storm totals that are not useful



Example Radar QC

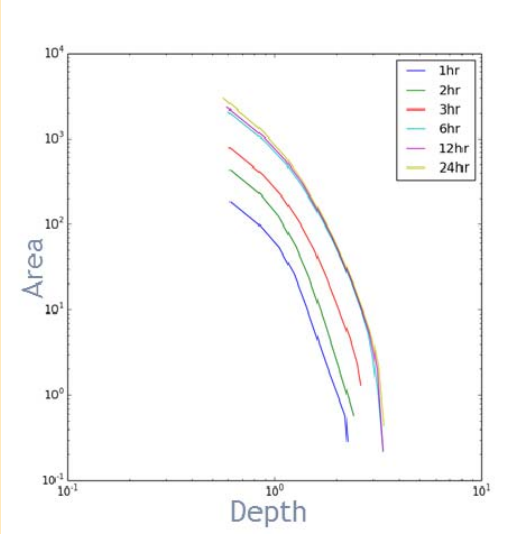


Terrain induced returns (AP) that occurred across HHA 1 during the 6/8/2009 event



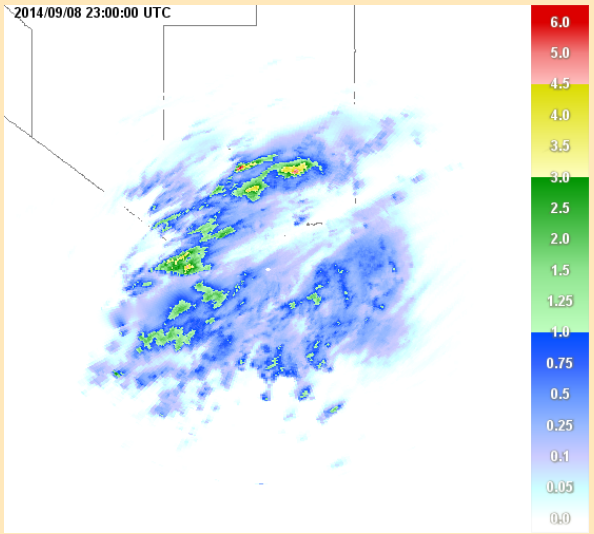
Develop Depth-Area-Duration (DAD) Values

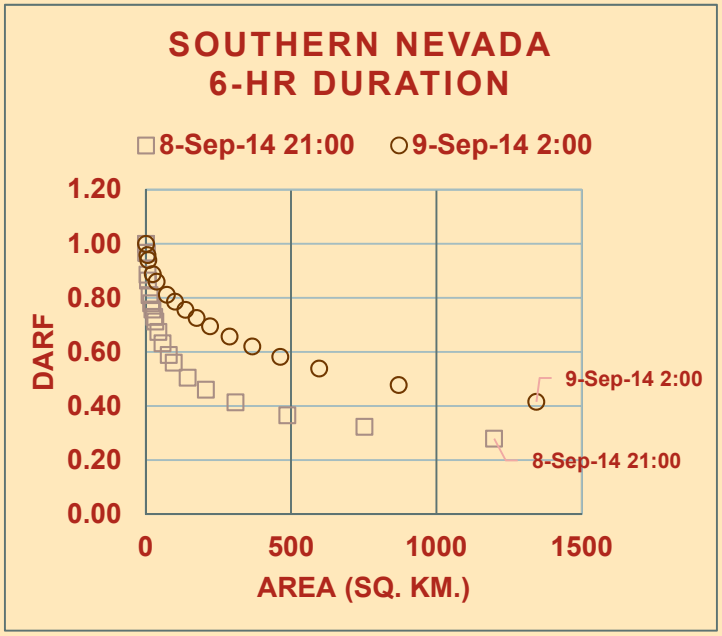
- From the storm event aggregations, depth-area-duration (D-A-D) values were computed.
- Area was determined for the average storm total depths >0.25-inches
- D-A-D period with the maximum depth selected for analysis



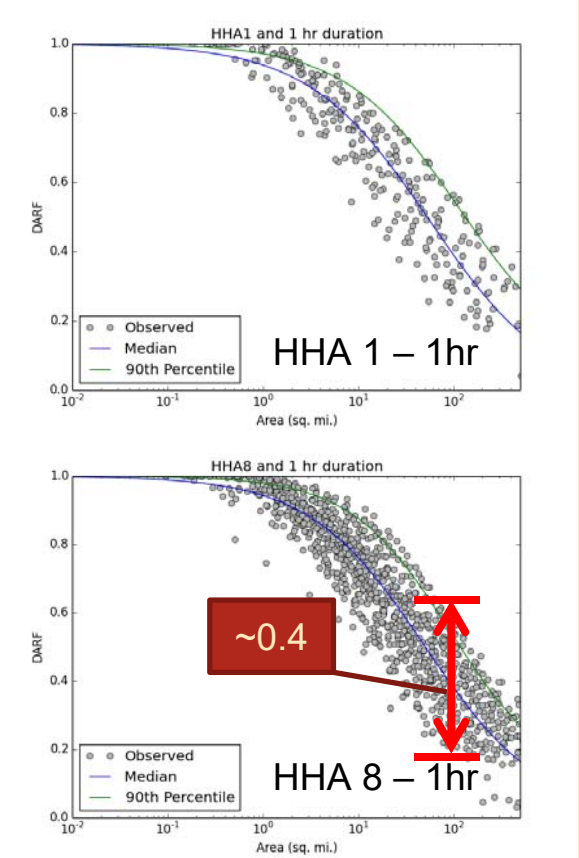
Depth-Area
North American Monsoon 2014

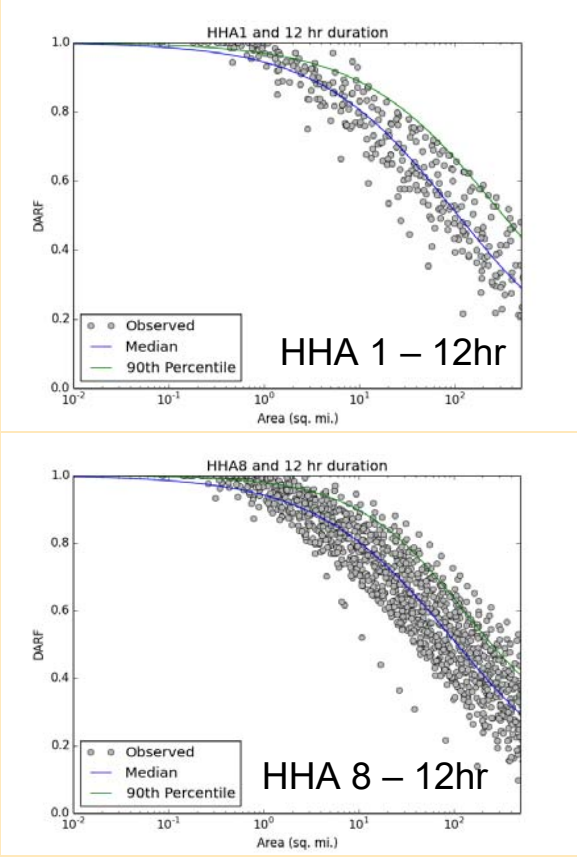
Storm Total - 6-hr Aggregations from 8-Sep-14 to 9-Sep-14





DARFs at 90th and 50th Percentile

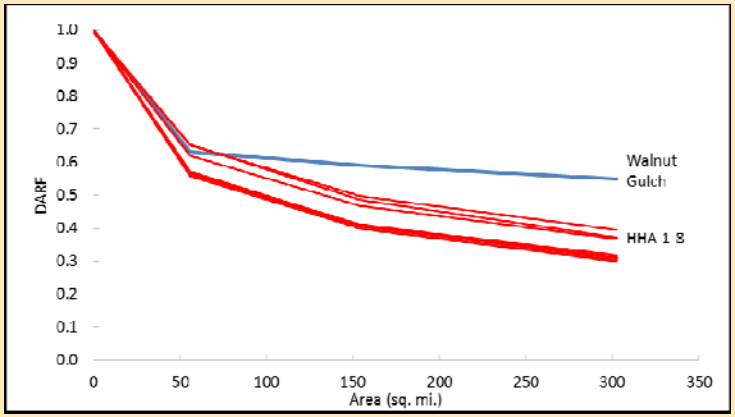




Walnut Gulch Arizona

Geographically Fixed

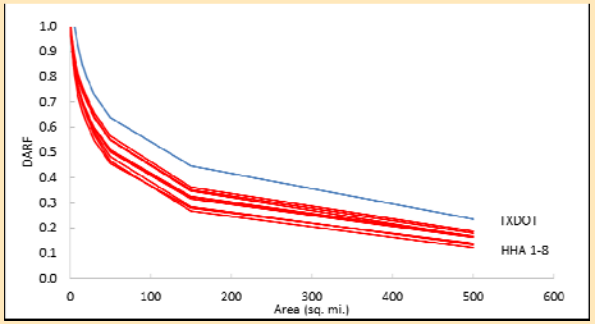
- USDA Agricultural Research Service (ARS) in the Walnut Gulch watershed located near Tucson, AZ, 388 sq. km. (150 sq. mi.)
- GF analysis of network consisting of 107 gauges at an average elevation of 4,656-ft. msl.
- DARF in close agreement for areas from 0- to 50-sq. mi.



6-hr duration DARF curves for Walnut Gulch (blue) and median DARF curves for HHA 1 through HHA 8 (red)

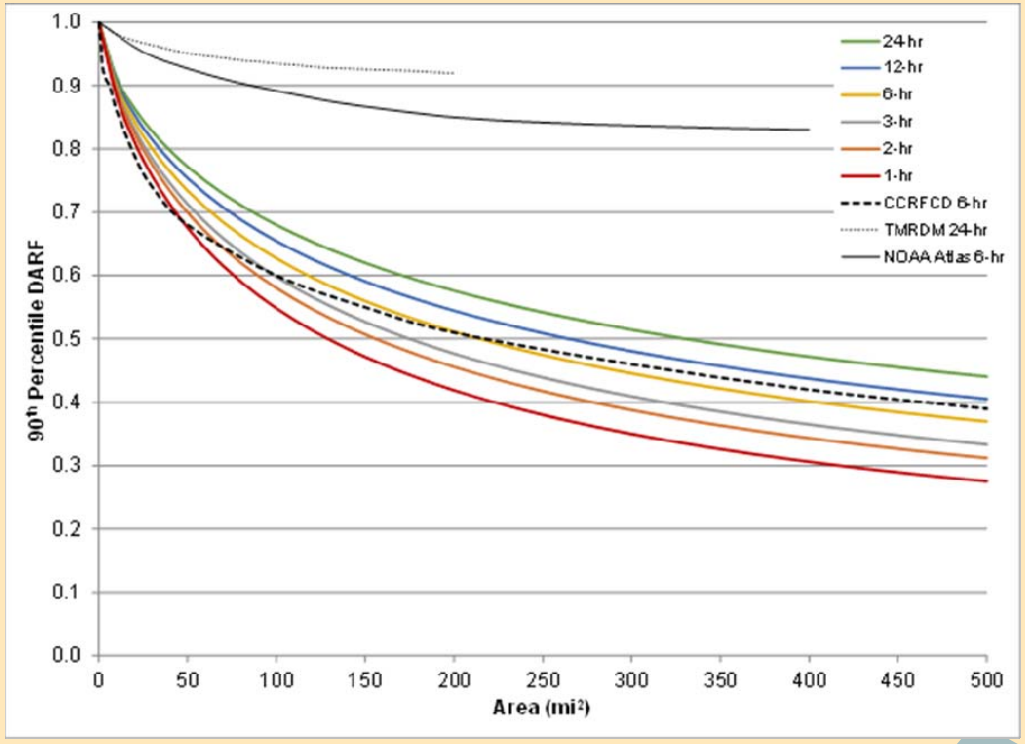
Texas Department of Transportation

- Olivera et al. (2005) statewide analysis for Texas Department of Transportation (TXDOT)
- Composed of storms from a two-year period using radar data at 4x4-km resolution in an SC-type analysis framework.
- DARF for HHA 1 – 8 compare well in shape, but with less reduction.
- Shape is encouraging given that the TXDOT study is radar based and comprises many storms
- Climatological differences may produce larger storm cells in Texas than Nevada

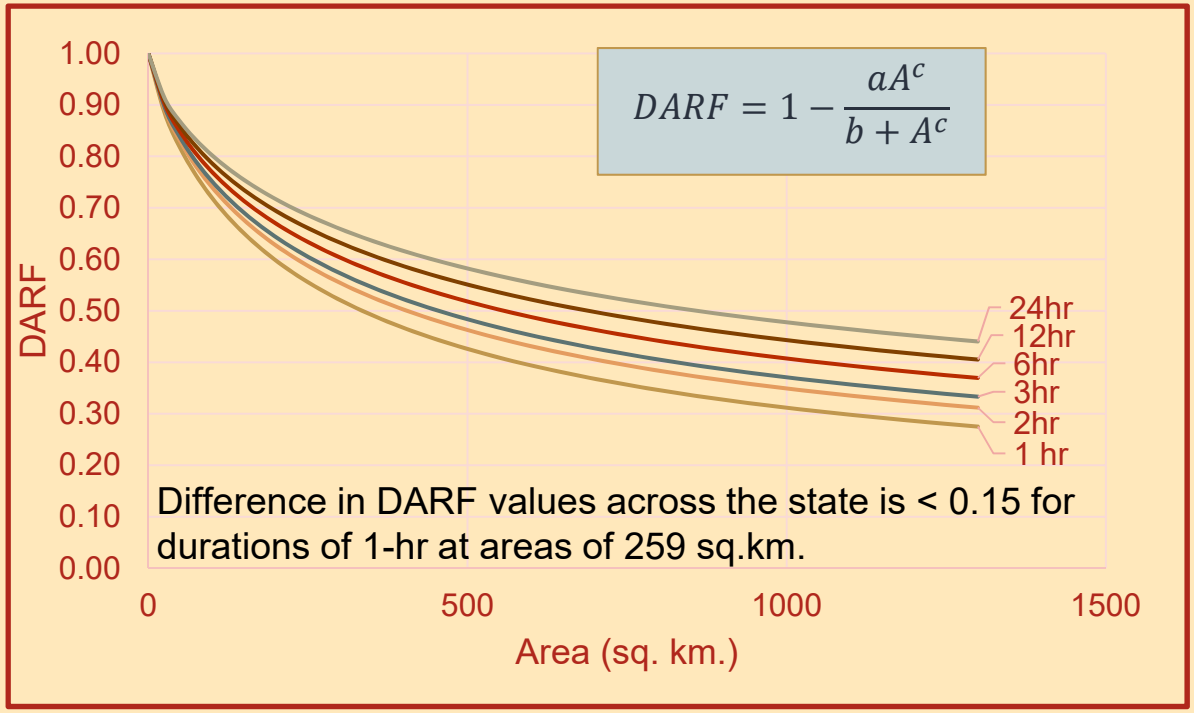


1-hr duration DARF curves for TXDOT (blue) and median DARF curves for HHA 1 through HHA 8 (red)

Comparison


1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
90th Percentile DARF
0
50
100
150
200
250
300
350
400
450
500
Area (mi²)
24-hr
12-hr
6-hr
3-hr
2-hr
1-hr
CCRFCD 6-hr
TMRDM 24-hr
NOAA Atlas 6-hr

Statewide 90th Percentile DARFs



Summary

New streamlined design storm procedures have been developed for the Nevada Department of Transportation.

- Radar data provided essential data for 547 events and 1,720 different durations
- Developed DARF relationships for 1, 2, 3, 6, 12, and 24hr durations at 50th and 90th percentile, statewide
- Importance of analyzing a large number of events is emphasized by the variation in DARFs for a given duration and area

Questions ?

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