RECLAMATION

Managing Water in the West

Extreme Precipitation Frequency for Dam Safety and Nuclear Facilities – A perspective

Workshop on Probabilistic Flood Hazard Assessment

January 29-31, 2013 Rockville, Maryland

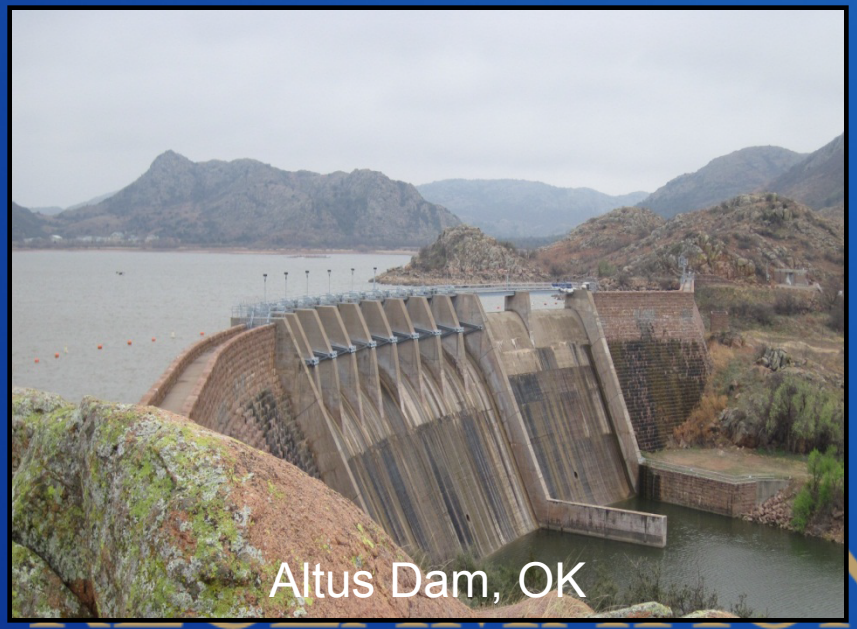
U.S. Department of the Interior
Bureau of Reclamation

Case Studies


Star Fort Dam, SC

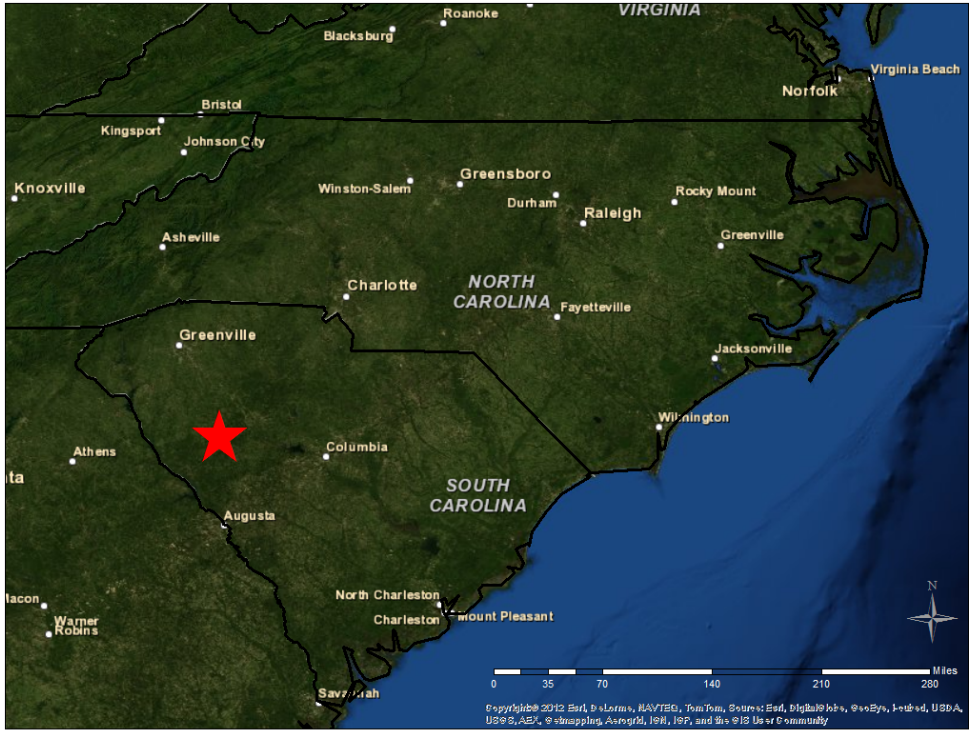

Trapped Rock Dam, NM

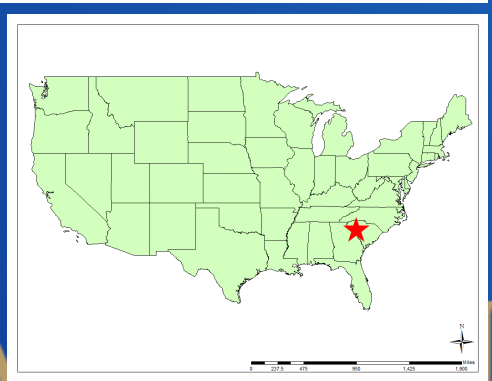

Anderson Ranch Dam, ID


Altus Dam, OK

Star Fort Dam

- Owned by the National Parks Service, located in Ninety Six National Historic Site
- Flood control structure
- Built in the 1930s
- Drainage area is 1.15 mi^2



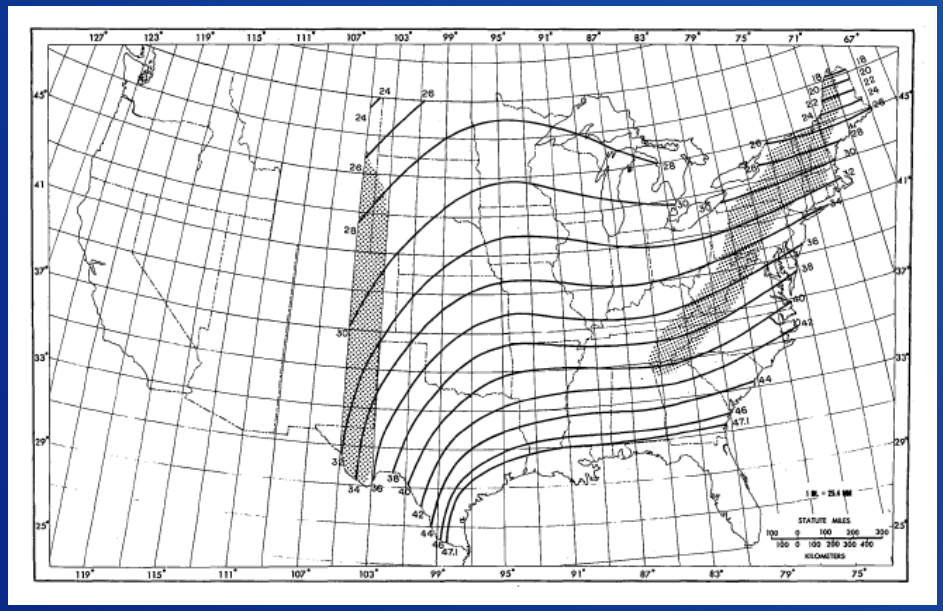


Compute the PMF and flood frequency analysis for screening

Requires PMP and precipitation frequency

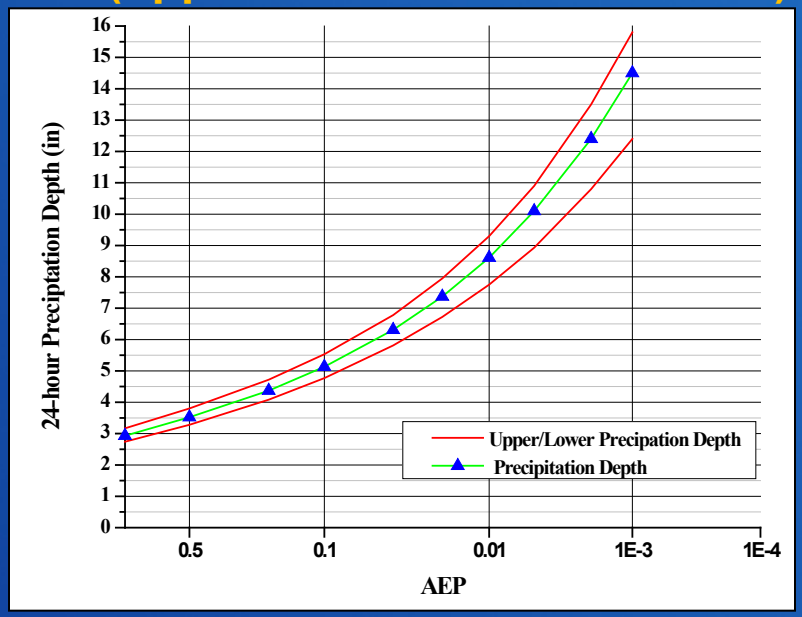
Star Fort Dam

Compute the PMF from the PMP

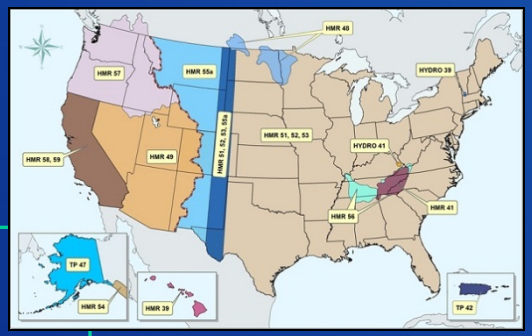


HMR 51 (published 1978)
PMP = 41” in 24-hours

Compute flood frequency up to 1,000-yr (upper limit of NOAA Atlas 14)



NOAA Atlas 14
14.5” in 24-hours
for 1,000-year event



PMP - the theoretically greatest depth of precipitation for a given duration that is physically possible over a given size storm area at a particular geographical location at a certain time of year.

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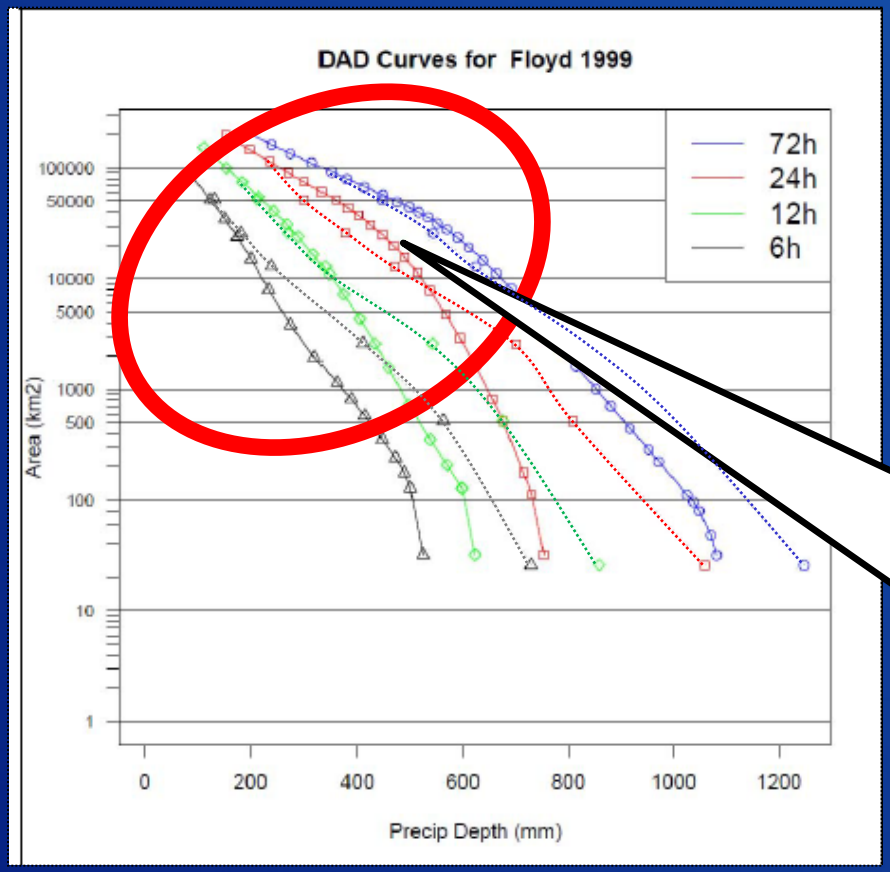
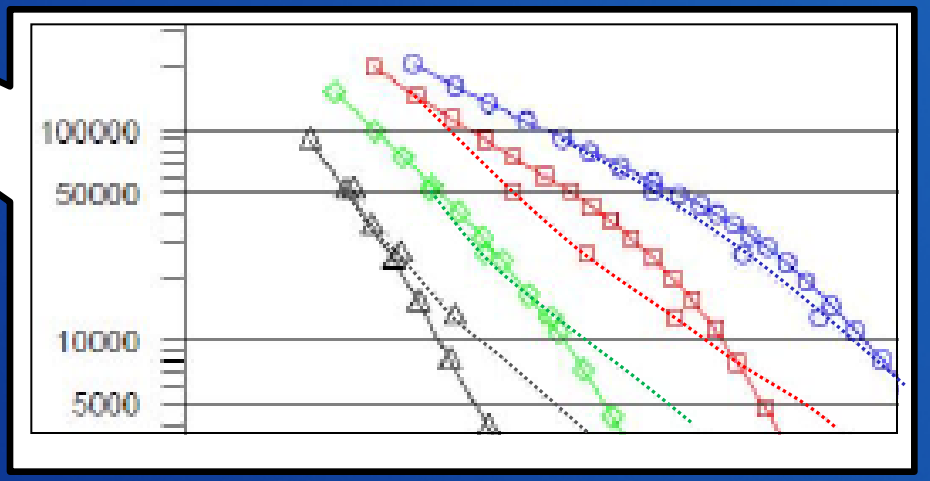
Current Understanding

Compute the PMF from the PMP

New Storm Data for Eastern North Carolina



Hurricane Floyd, upon moisture maximization, exceeds PMP at 24-hr and 72-hr at large area sizes.



Caldwell et al. 2011

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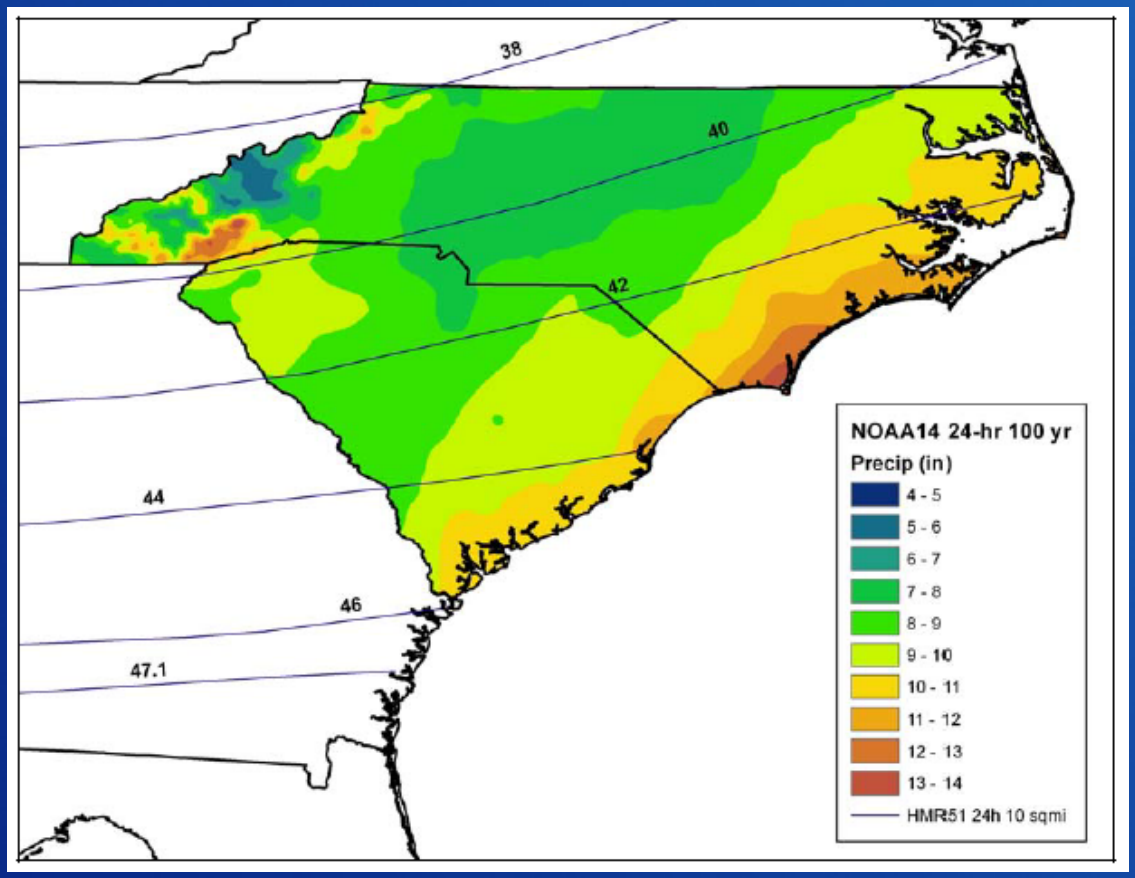
Current Understanding

Compute flood frequency

Resolution of NOAA Atlas 14 vs HMR 51



Caldwell et al. 2011

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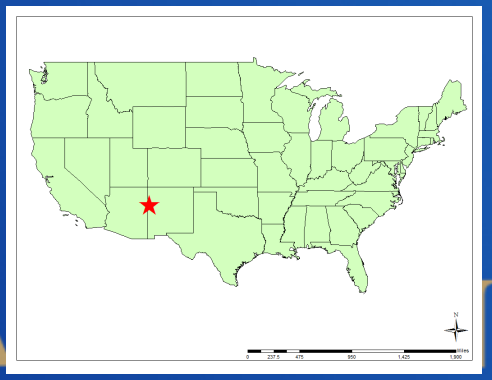
Trapped Rock Dam

- Owned by the Zuni Pueblo Indian Reservation, Bureau of Indian Affairs
- Flood control structure
- Drainage area is 2.88 mi^2

Flood Frequency Analysis

Requires Precipitation Frequency Analysis



Trapped Rock Dam

Australian Rainfall-Runoff method (ARR):

1. Assigns a probability to the PMP
2. Extrapolates between the credible limit of extrapolation and PMP using a 2-parameter parabolic function in log-log space

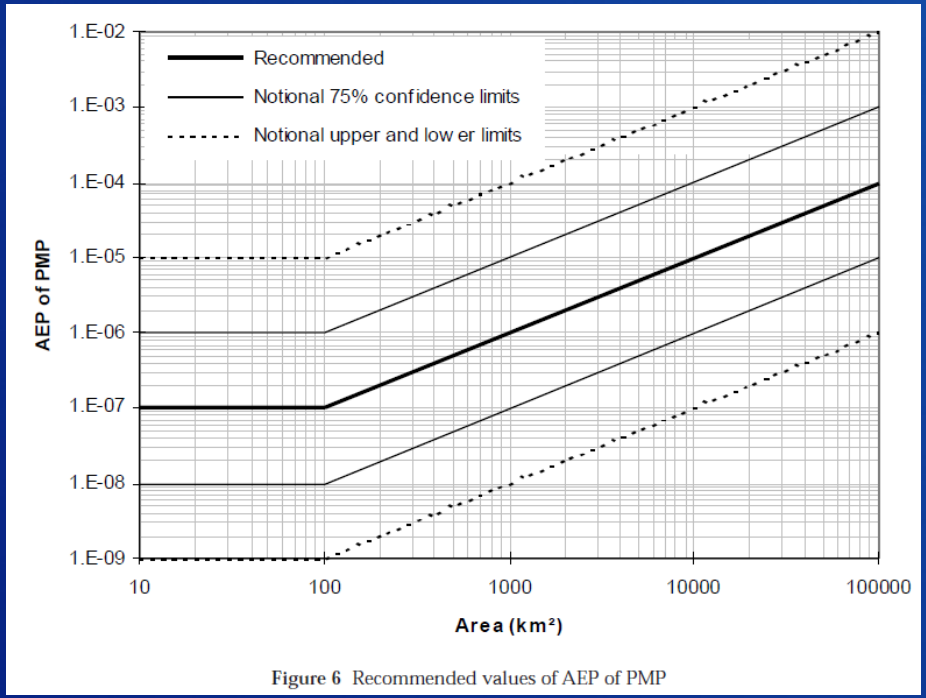
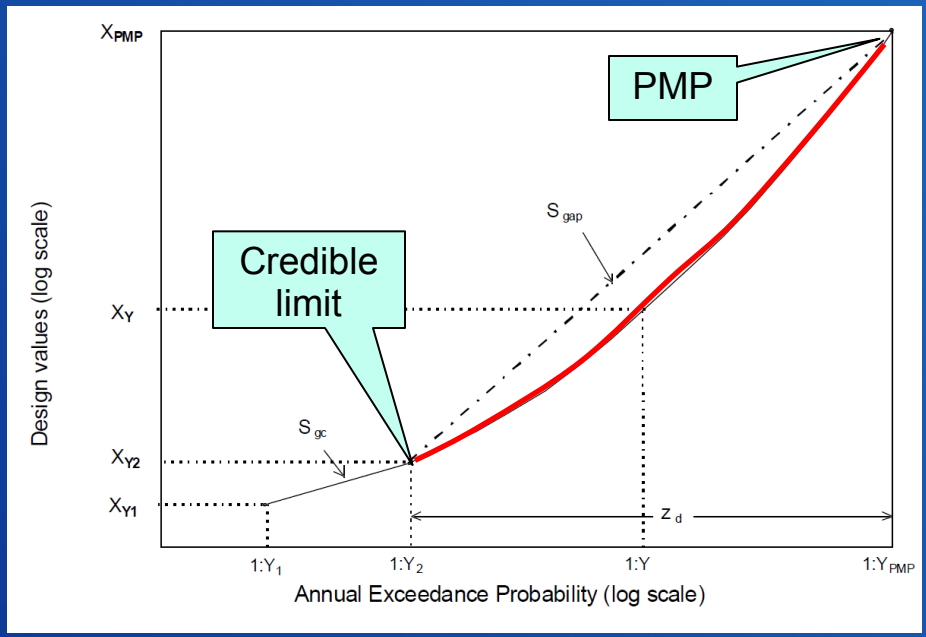


Figure 6 Recommended values of AEP of PMP



Nathan and Weinmann, 2000

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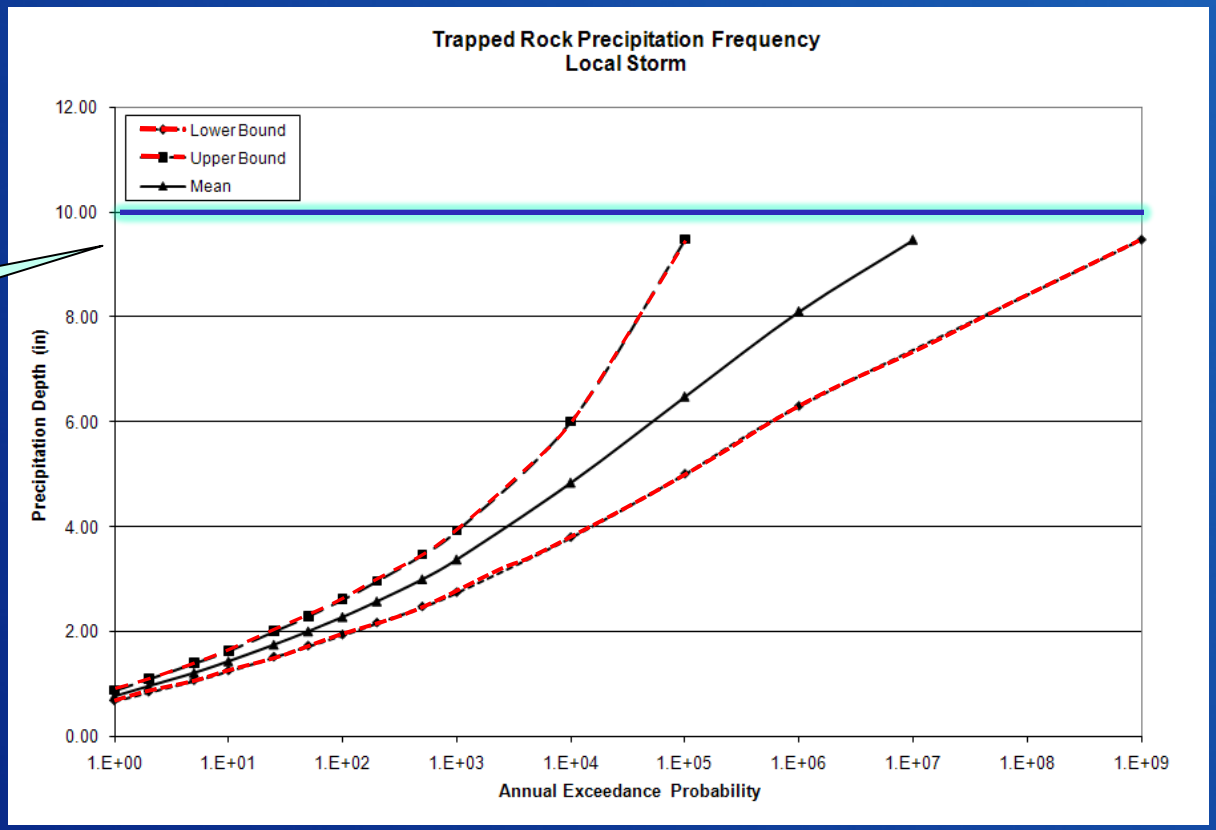
Current Understanding

Uncertainty on PMP



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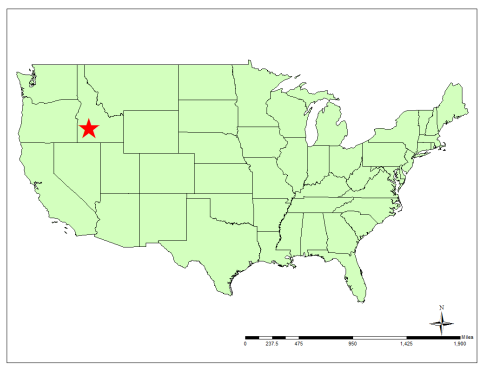
Anderson Ranch Dam

- Owned by Reclamation
- Storage structure
- World's highest earthfill dam at the time of construction
- Drainage area is ~975 mi^2

Detailed flood hydrology study for the Dam Safety Office

Requires precipitation frequency + storm patterns



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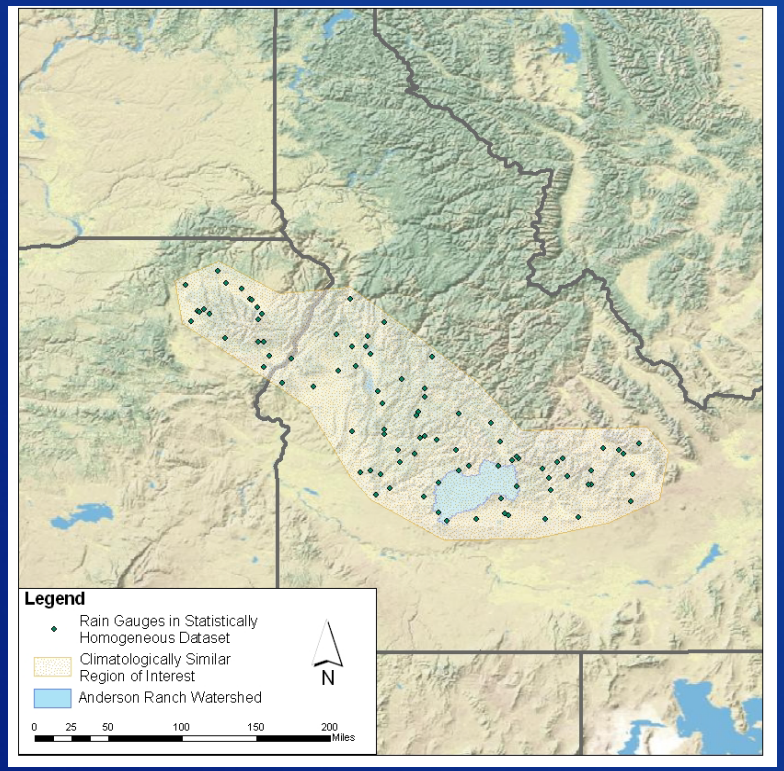
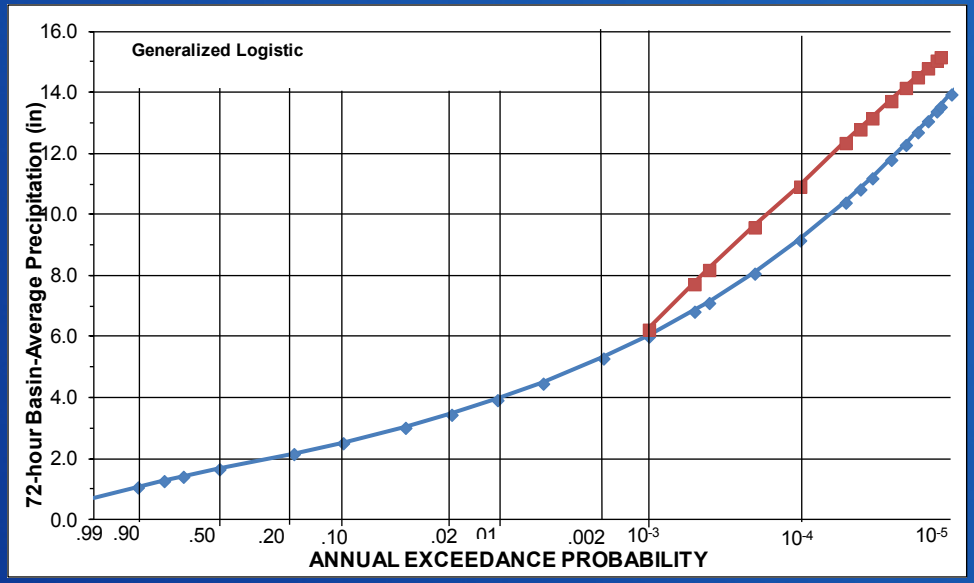
Anderson Ranch Dam

Precipitation frequency using multiple methods: ARR and L-moments





ARR = red curve

L-moments = blue curve

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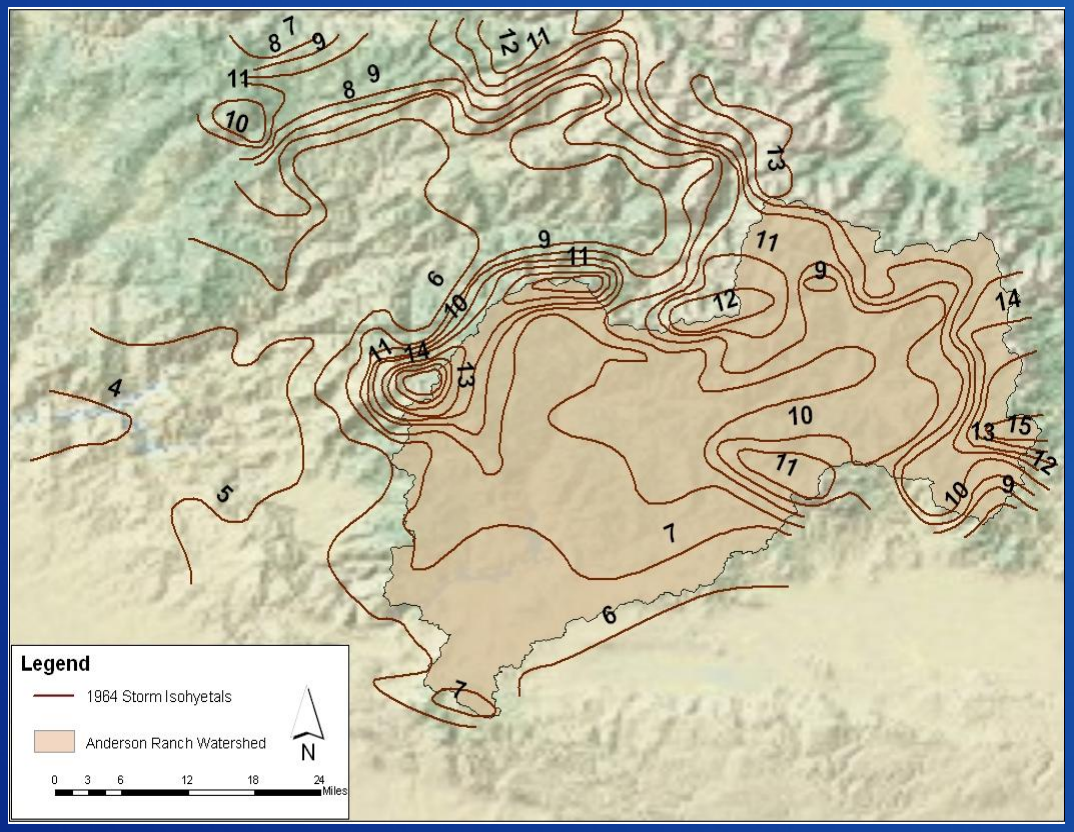
Anderson Ranch Dam

Storm spatial patterns



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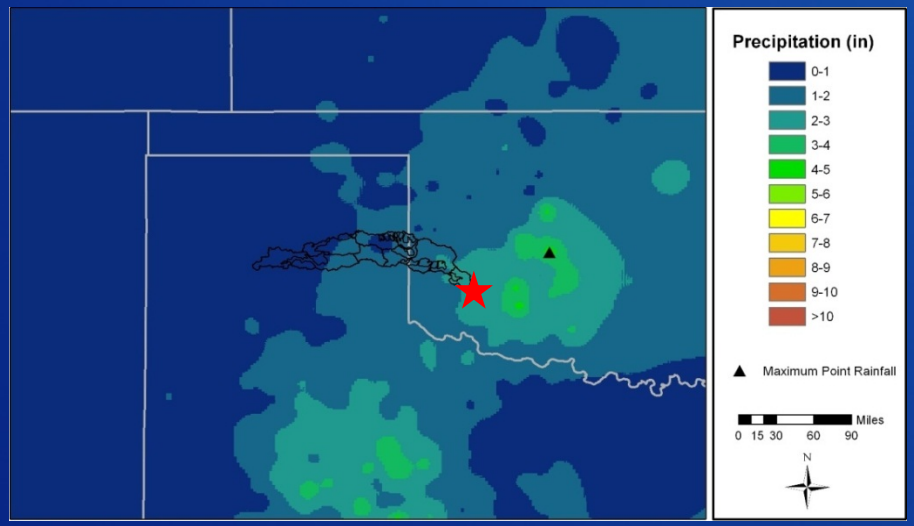
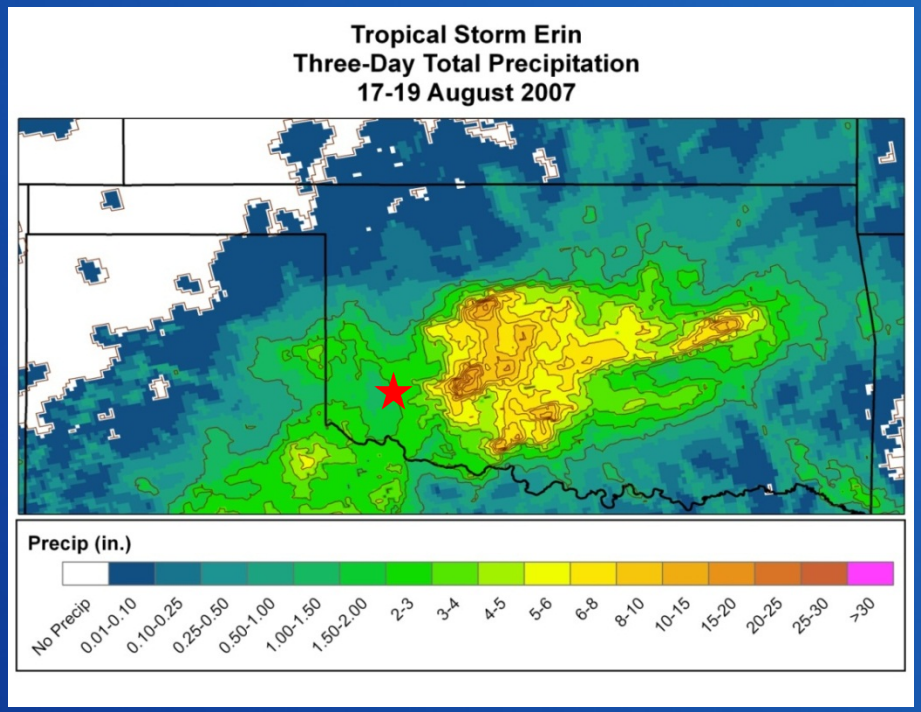
Evolving Ideas

Radar derived rainfall for spatial pattern





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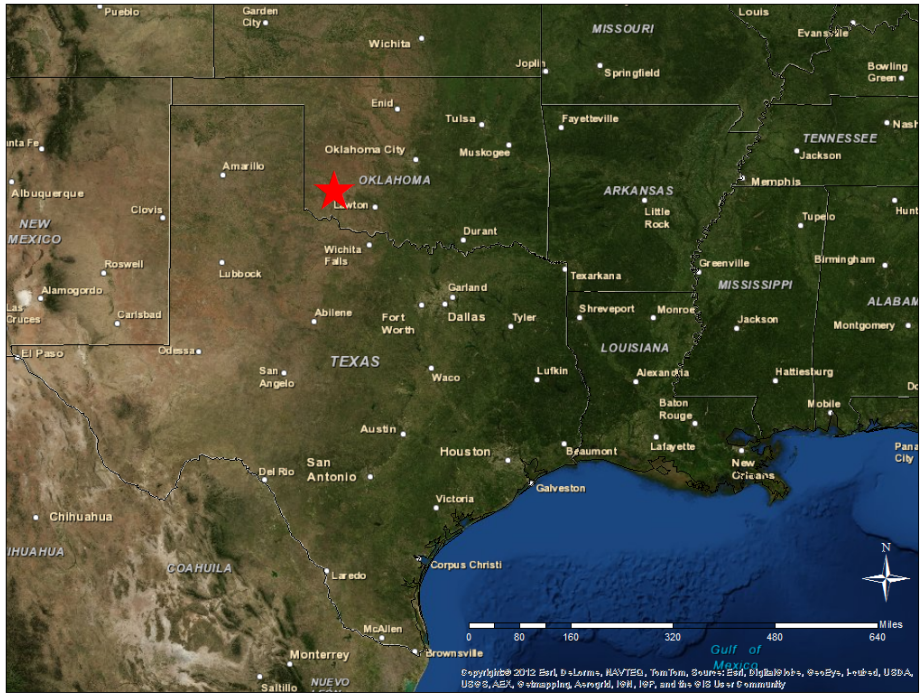
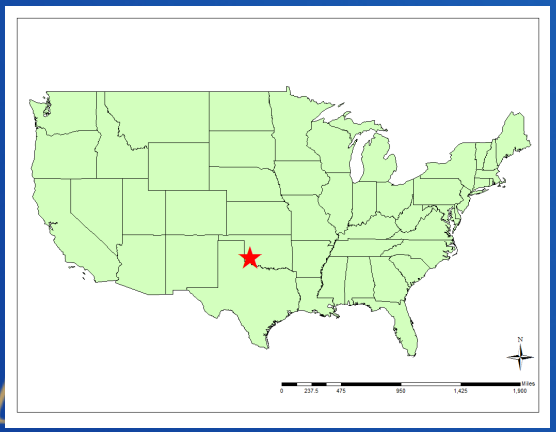
Altus Dam

- Owned by Reclamation
- Irrigation storage structure
- Contributing area is ~1951 mi^2



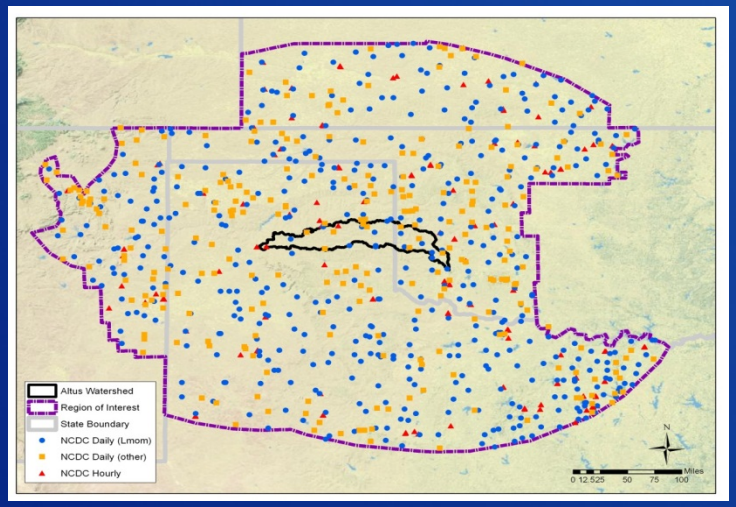
Detailed flood hydrology study for the Dam Safety Office

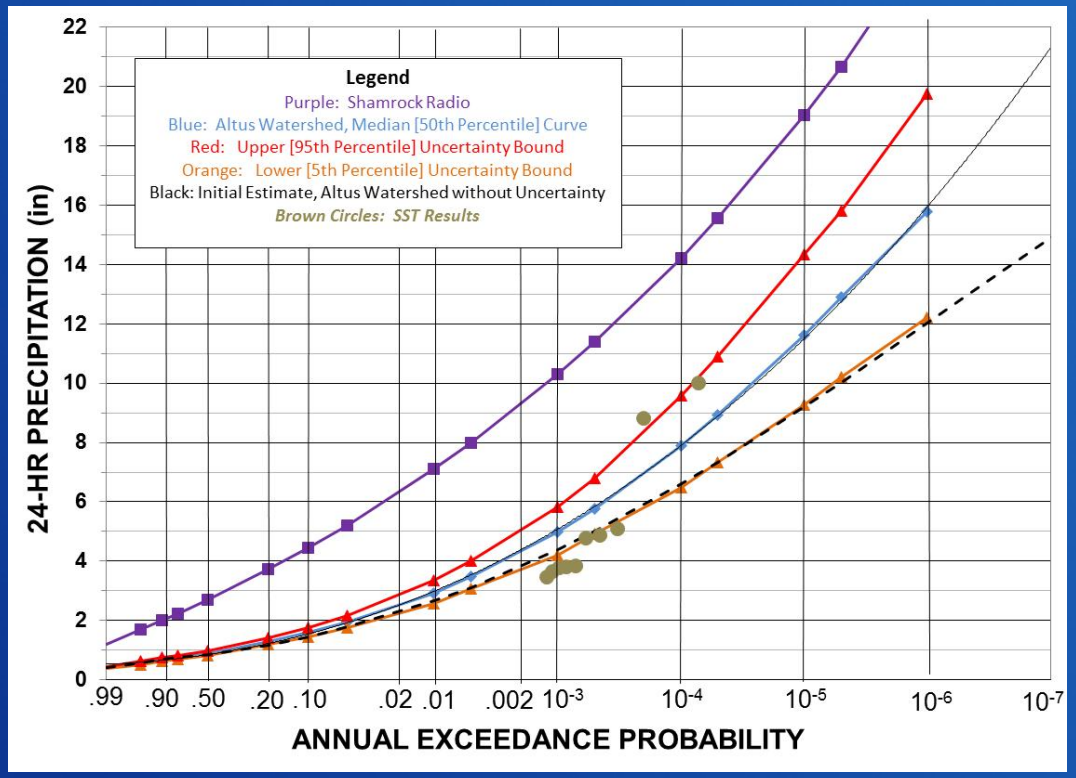
Requires precipitation frequency + storm patterns to run SEFM



Altus Dam

Precipitation frequency from L-moments

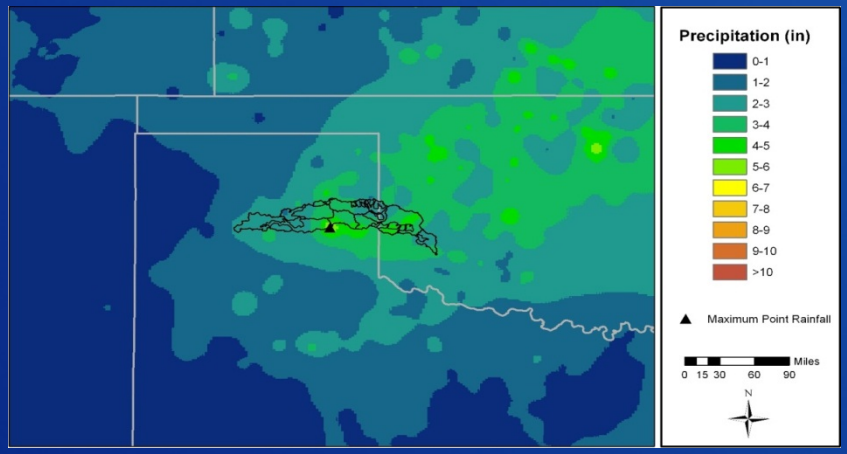


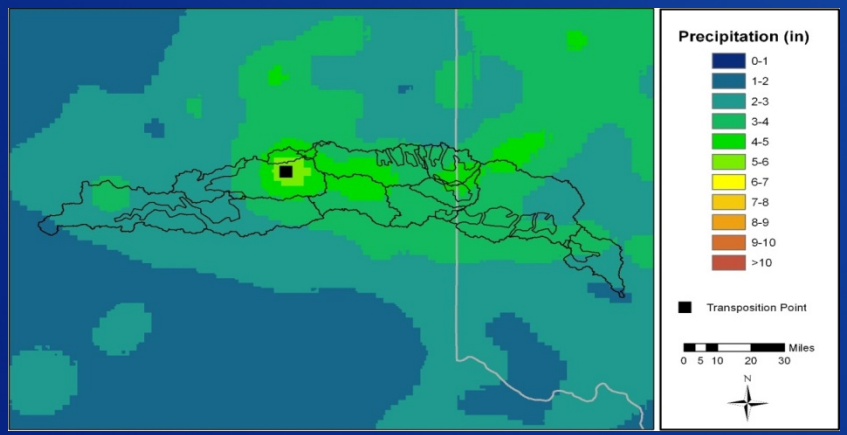


RECLAMATION

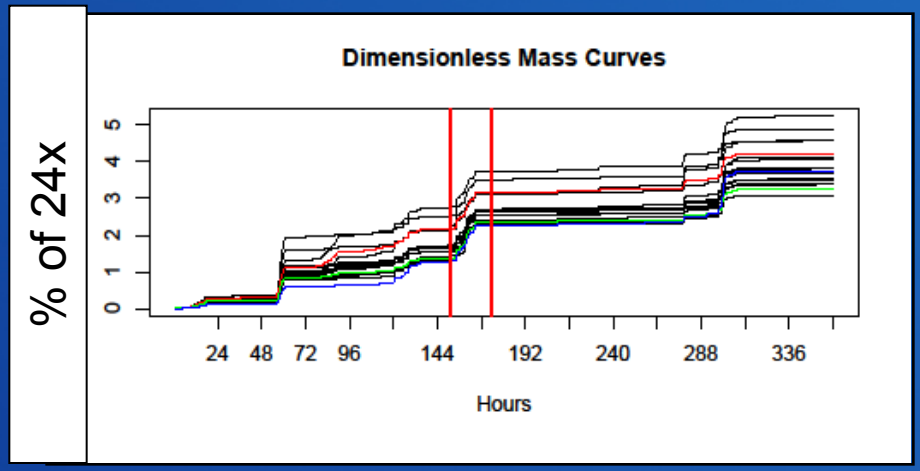
Altus Dam

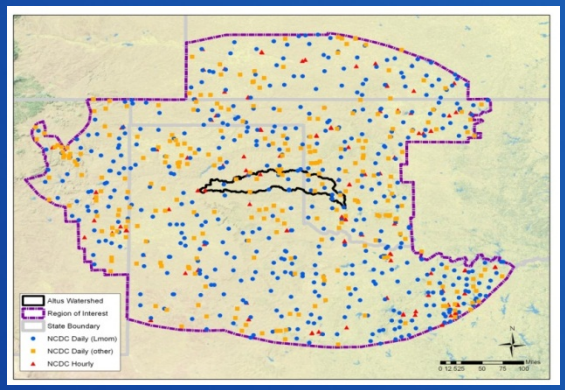
Storm spatial patterns





May 22, 1972





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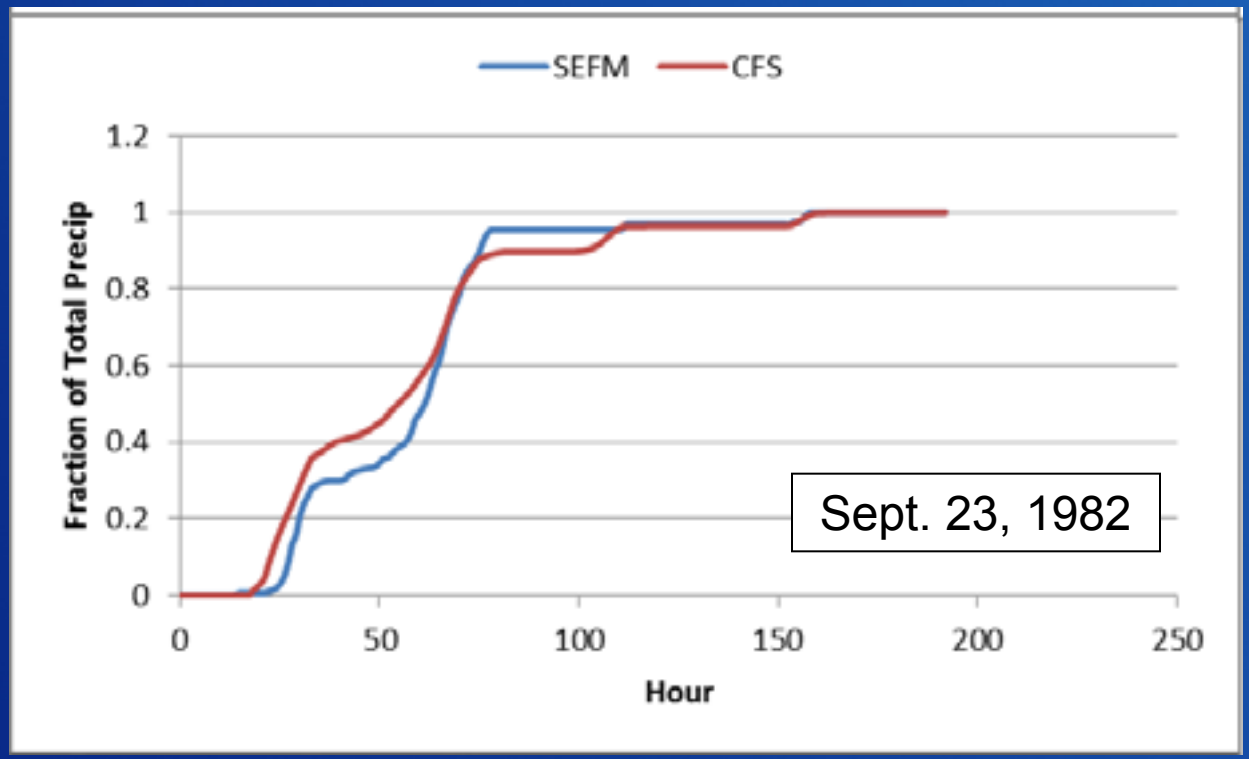
Evolving Ideas

Temporal pattern (mass curves) from model data (CFS-R)



Summary

- Scaled approach (based on size of dam and consequences)
- In-house, site-specific work
- Precipitation frequency curves
- PMP is used as a consideration
- Uncertainty
- Methods are evolving

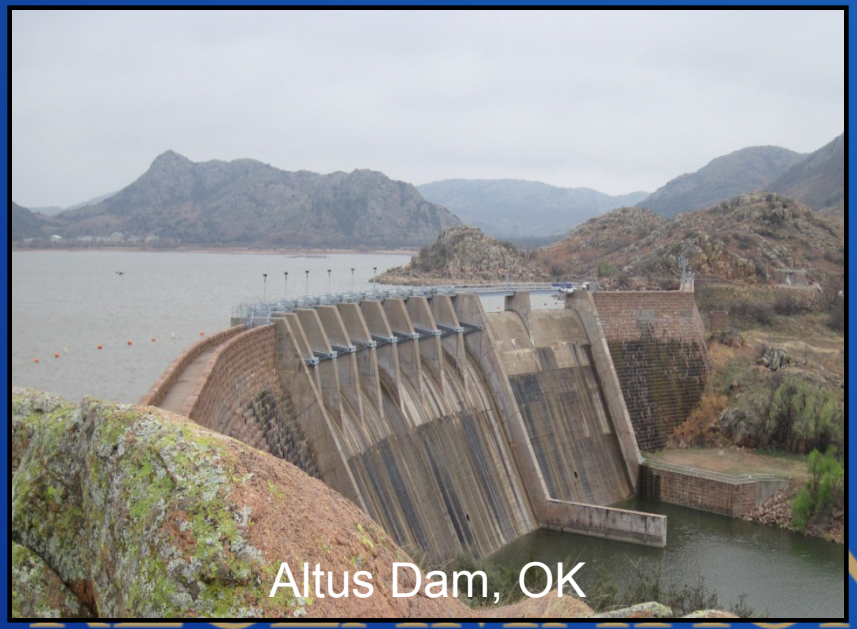



Case Studies


Star Fort Dam, SC


Trapped Rock Dam, NM


Anderson Ranch Dam, ID


Altus Dam, OK