


RECLAMATION

Managing Water in the West


RIC 2010

Updating Estimates of Extreme Precipitation

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Bureau of Reclamation




Extreme Precipitation Estimates


- Two Categories for Hierarchical Hazard Assessment
- **Deterministic, Upper Limit**
 - Probable Maximum Precipitation
 - Used as Design Maximum Precipitation in NuREG 1.59
- **Probabilistic, Risk-Based Estimates**
 - Precipitation Frequency (NOAA 14)
 - Stochastic Storm Transposition with Depth-Area-Duration (D-A-D) Data: Yankee Atomic Energy, 1985; NRC, 1988
 - Detailed Regional Precipitation Frequency (LMoments)

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High-Hazard Structures



Bellefonte, AL



Morrow Point, CO

Goal: protect public from potential failure of high-hazard structures
Design Flood Standards – PMP and PMF; Risk

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Hazard Focus: Riverine Flooding; Local Flooding from Extreme Precipitation



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Probable Maximum Precipitation (PMP)

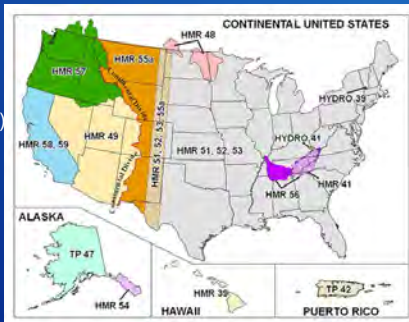
Definition: Theoretically, the greatest depth of precipitation for a given duration that is physically possible over a given storm area at a particular geographical location at a certain time of year (HMR 52).

Use: PMP is used (in many cases) for the upper limit design precipitation estimate for the design and assessment of critical infrastructure.

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Probable Maximum Precipitation (PMP)

PMP Estimates:
PMP from NWS
Hydromet.
Reports (HMRs)
Generalized vs.
region or site-
specific studies



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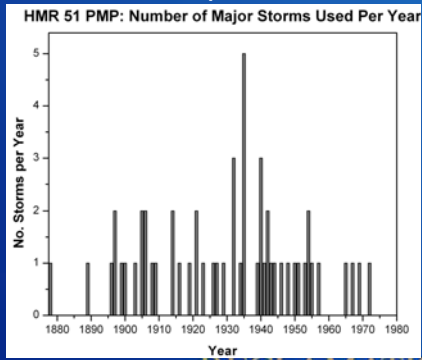
Basic Problem: Outdated Design Precipitation Estimates

HMR No.	Publication Date	Latest Storm Used	Comments
49	1977	Sept. 3-7, 1970	see HMR 50 for storm info; 1983 Prescott, AZ storm exceeds PMP
51	June 1978	June 19-23, 1972	Replaced HMR 33 (1956)
55A	June 1988	Aug. 1-4, 1978	Replaced HMR 55 (1985) and TP 38 (1960)
57	October 1994	Dec. 24-26, 1980 (general) Aug. 16, 1990 (local)	Replaced HMR 43 (Nov. 1966)
59	February 1999	Feb. 14-19, 1986	Replaced HMR 36 (Oct. 1961)

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Basic Problem: Temporal Limitations

HMR51:
53 Major Storms used for PMP in Eastern US



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Basic Problem: Spatial Limitations

HMR51:
53 Major Storms used for PMP in Eastern US



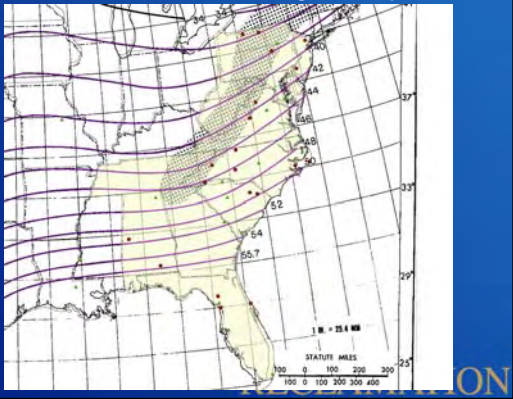
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New Extreme Storm Catalog From Existing D-A-D Data

- Digital (GIS) HMR 51
- Storms analyzed and used in HMR 23, 33 and 51
- Focus on Critical and Controlling Storms in Southeast: **74 storms**
- PAPER copies of data – scanned for major storms
- Electronic Catalog

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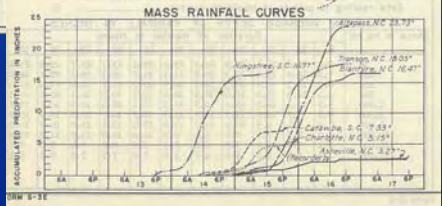
HMR 51 PMP: New Digital Layers



Depth-Area Duration (D-A-D) Data

Altapass, NC July 13-17, 1916

Area in Sq. Mi.	MAXIMUM AVERAGE DEPTH OF RAINFALL IN INCHES										
	6	10	15	20	30	36	48	60	72	96	120
10	5.7	10.0	11.5	15.1	15.5	15.6	15.8	15.8	15.8	15.8	15.8
100	5.4	10.5	13.7	15.0	15.3	15.9	16.7	16.7	16.7	16.7	16.7
1000	5.2	10.5	13.5	11.9	15.1	15.7	16.4	16.5	16.5	16.5	16.5
5000	4.9	9.8	12.5	11.4	14.5	15.2	15.7	15.9	15.9	15.9	15.9
10000	4.6	9.2	11.7	13.5	13.7	11.4	15.0	15.1	15.1	15.1	15.1
20000	4.2	8.5	10.6	12.2	13.4	13.2	13.9	11.0	11.0	11.0	11.0
50000	3.5	6.9	8.7	10.6	10.4	11.2	11.8	12.0	12.0	12.0	12.0
100000	2.8	5.4	7.0	8.1	8.7	9.5	9.8	10.0	10.2	10.2	10.2



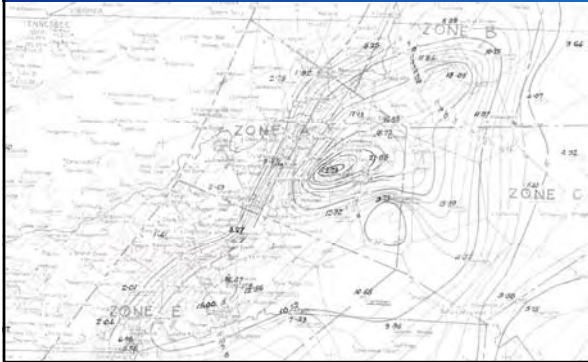
Alta Pass
13-17 July 1916



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Depth-Area Duration (D-A-D) Data

Altapass, NC July 13-17, 1916



SE US Important Storms: D-A-D Data

74
Existing
Storms in
SE (blue
triangles)

Much
Larger
Spatial
Coverage



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NEW Data Sets For Extreme Storm Catalog

- Initial Gathering and Storm Processing
- All Electronic: HIGH Spatial and Temporal Res.
- NOAA Atlas 14 Vol. 2: Precipitation Frequency
- CoCoRAHS
- NEXRAD Level II/III and NEXRAD-Based Multisensor Precipitation Reanalysis – NCDC
- HURDAT and IBTRACs

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NOAA Atlas 14 Precipitation Frequency Data

Maximum 1-day
Precipitation
at all COOP
stations

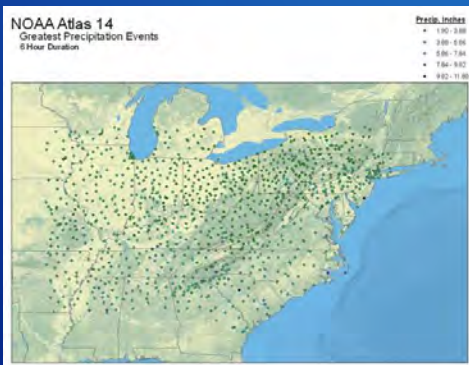


time series data:
<http://hdsc.nws.noaa.gov/hdsc/pfds/>

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NOAA Atlas 14 Precipitation Frequency Data

Maximum 6-hour
Precipitation
at all hourly
stations



time series data:
<http://hdsc.nws.noaa.gov/hdsc/pfds/>

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Record
September
2009 GA
rainfall data
from
CoCoRAHS



Community Collaborative Rain, Hail and Snow Network
<http://www.cocorahs.org>

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NEXRAD LEVEL III: NCDC

Individual
Storms

High-Res
Spatial/
Temporal Data
Estimate
Precipitation
from reflectivity

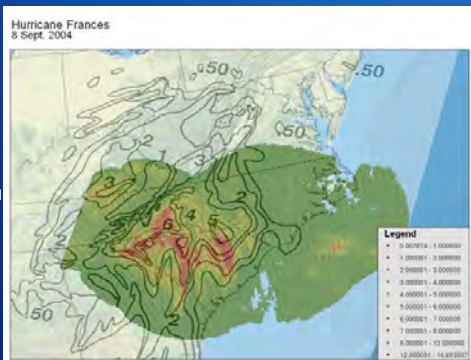


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NEXRAD-MPR

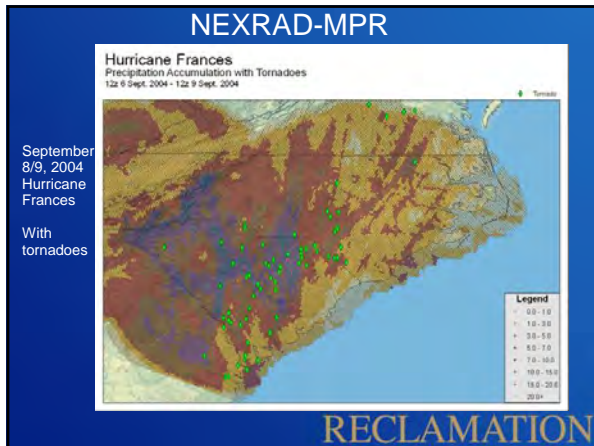
September 8,
2004
Hurricane
Frances

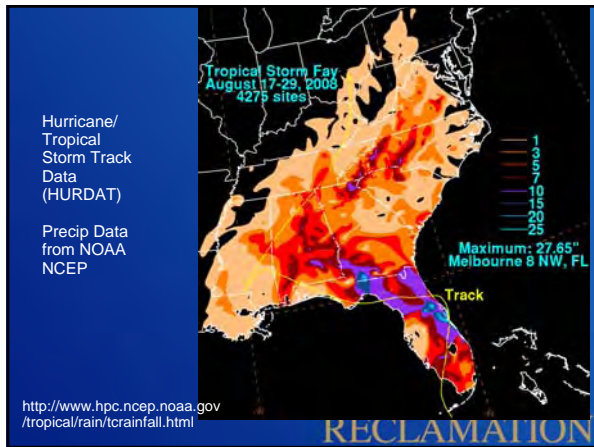
Direct Rainfall
Estimates
1 hr, 4x4 km



<http://www.ncdc.noaa.gov/thredds/catalog/radar/MPR/>

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Extreme Rainfall Probabilities: Stochastic Storm Transposition

$$G^a(d) = p_a(\bar{d}_c \geq d) = \hat{p}_s \sum_{j=1}^{N_s} \hat{p}_j (\bar{d}_c \geq d) \left(\frac{A_{df,j}}{A_r} \right)$$

Idea: space-for-time substitution
D-A-D extreme storm catalog

Basin-Average Rainfall for Time Δt

Joint Probability: reduce extrapolation
Extreme storms occurring in transposition region
→ **extreme storm probability**
Extreme storm causing a depth exceedance over catchment of interest
→ **transposition probability**

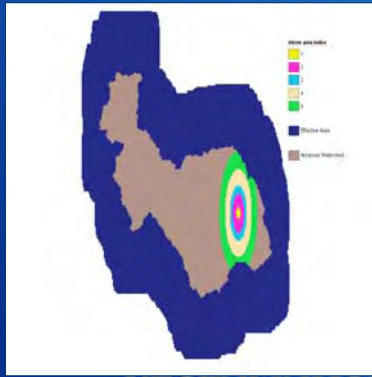
Concepts from NRC-funded National Academy Report, 1988; Yankee Atomic Energy

Extreme Storms in Transposition Region

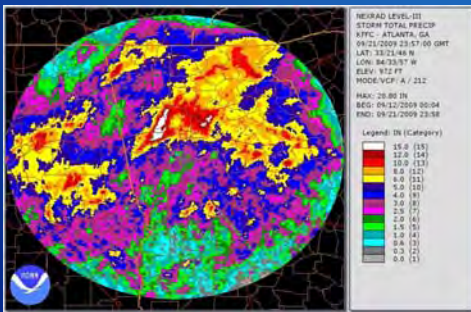


SST Implementation: A_{eff}

A_{eff} : area within which the storm must be centered and still cover at least one point within the catchment



QUESTIONS?



<ftp://ftp.usbr.gov/jengland>; jengland@usbr.gov
