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NRC Commission Meeting on Flooding and Other Extreme Weather

FLOODING

Presenter

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Lance W Vail

- Senior Research Engineer
- Hydrology Group
- Pacific Northwest National Laboratory (33 years)
- Richland, Washington

Research Focus

- Water and Energy Nexus
- Water Resource Systems
- Advanced Hydrologic Models
- Climate Impacts on Water Resources

Projects

- Department of Energy
- Environmental Protection Agency
- NOAA
- NASA
- Nuclear Regulatory Commission

Yakima River

Presentation Outline

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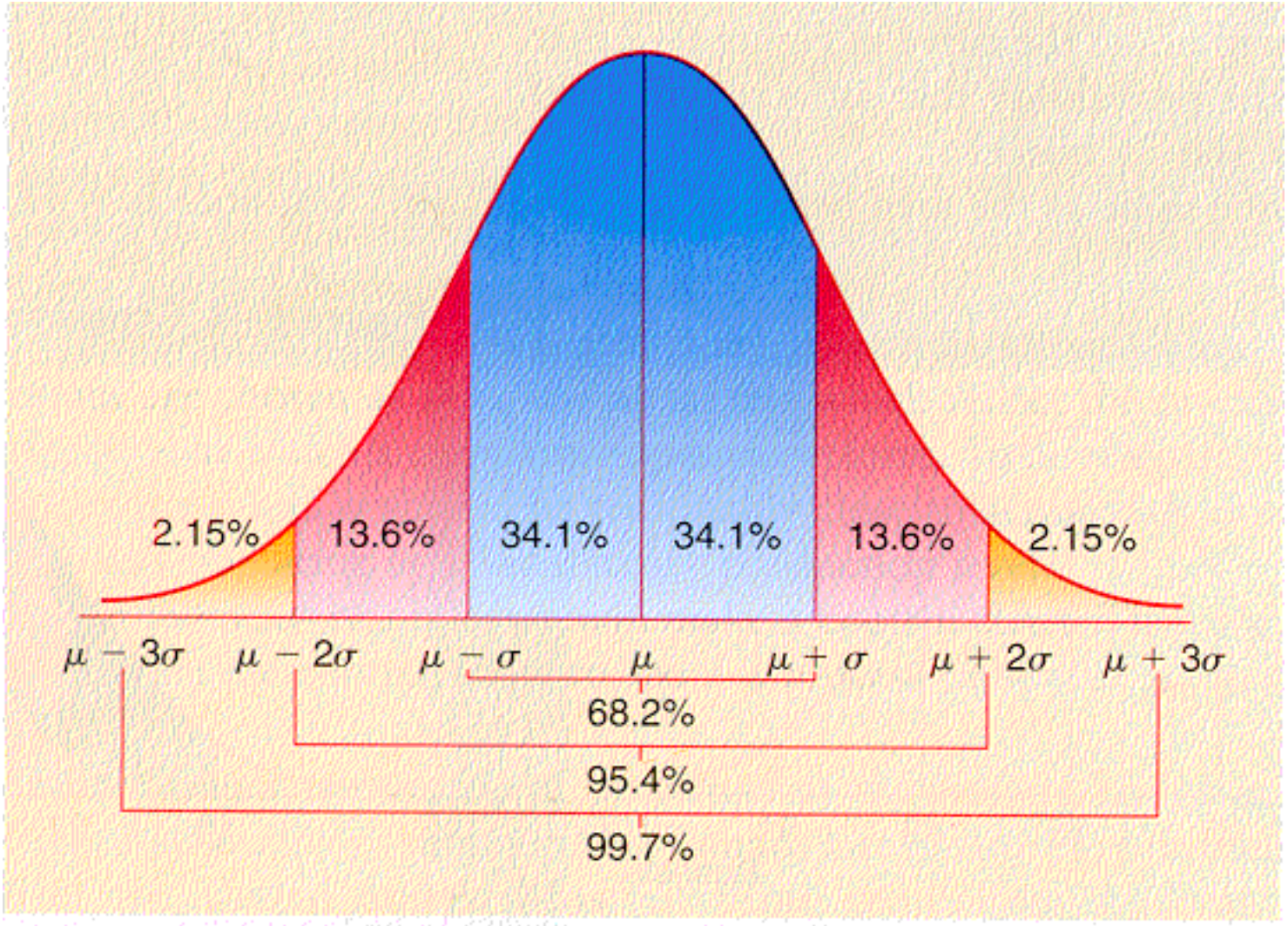
- Lessons Learned
- Flooding (Tale of Tails)
- Flooding with Climate Change (Tale of Moving Tails)
- Extreme Floods
- Probable Maximum Precipitation
- Sea Level Rise and Coastal Flooding
- Conclusions

Tails and Sigmas



Lessons Learned
American River Watershed Climate Study

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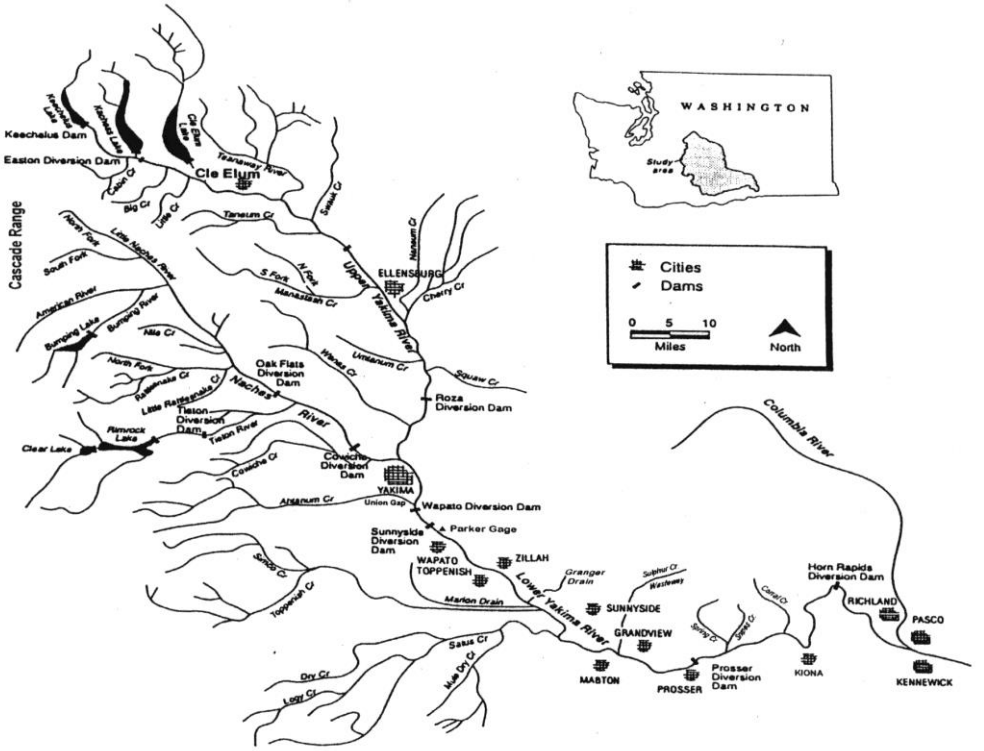
- Changes in tails are more meaningful than changes in means
- Tails (flood and drought) are meaningful
- Limited period of future records limits consideration of even 1-sigma levels
- Patterns in climate systems are crucial



Lessons Learned
EPA STAR Grant – Yakima Basin

- Address conceptual model uncertainty explicity
  - Climate change
  - Land use change
  - Water control infrastructure changes
  - Water use change
  - Hydrological and meteorological uncertainties
- Large ensemble simulation of multiple plausible conditions

Lessons Learned
Accelerated Climate Prediction Initiative

- Bias correction needed to future meteorological record
- Relatively short period of climate simulations limits consideration extreme events of even 1-sigma level
- Forecasts can reduce impacts up to 1-sigma level

Lessons Learned
Flood Assessment Methodologies

- Revisiting required
  - Bulletin 17B
    - “This generalized skew map was original prepared for Bulletin 17 published in 1976. It has not been revised utilizing the techniques recommended in Bulletin 17B”
  - HMRs (1970-2013)
- More data but fewer streamflow measurement stations
- Changes in land cover and water control infrastructure

Flooding
Tale of Tails

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- Floods
  - 5, 10, 20 year floods
  - 100 year floods
  - Probable Maximum Flood (PMF)
  - Paleofloods
- Hydrological statistics based on stable environment
- It is well established that climate “changes irregularly, for unknown reasons, on all timescales” National Research Council – 1991
  - El Nino Southern Oscillation (ENSO) 5 year
  - Pacific Decadal Oscillation (PDO) 20-30 year
  - North Atlantic Oscillation (NAO)
- Hurst phenomena (1951)

Flooding and Climate Change
Tale of Moving Tails

- Additional factors of uncertainty
  - Less representative record
  - Nonstationarity
  - Uncertainty in future
- Can extreme event hydrological statistics be adapted to consider climate changes?
  - Long-term climate modeling linked with hydrological simulation to generate long-term streamflow records to estimate extreme event probability
  - Classify historical large-scale climate patterns associated with historical extreme events and adapt frequency estimate based on large-scale climate patterns in climate models
  - Identify ‘new’ climate patterns

Extreme Floods

- Flood Frequency Analysis
  - Log-Pearson Type III
  - Skew and Outliers Issues
  - Empirical with Stationarity Assumption
- Probable Maximum Flood
  - Deterministic
  - Flood resulting from Probable Maximum Precipitation

Probable Maximum Precipitation

- Definition
- Maximum?
  - Truncated Distribution
  - Physical Limits
- Deterministic Approach
- Hydrometeorological Reports (HMR 51 – 1978 ➔)
- Revising for climate change?

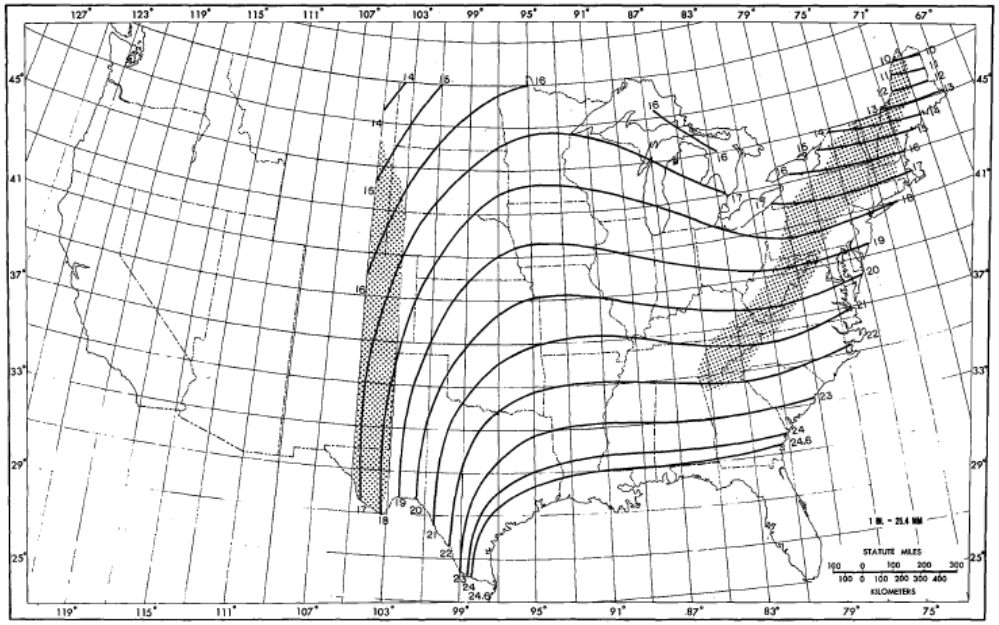
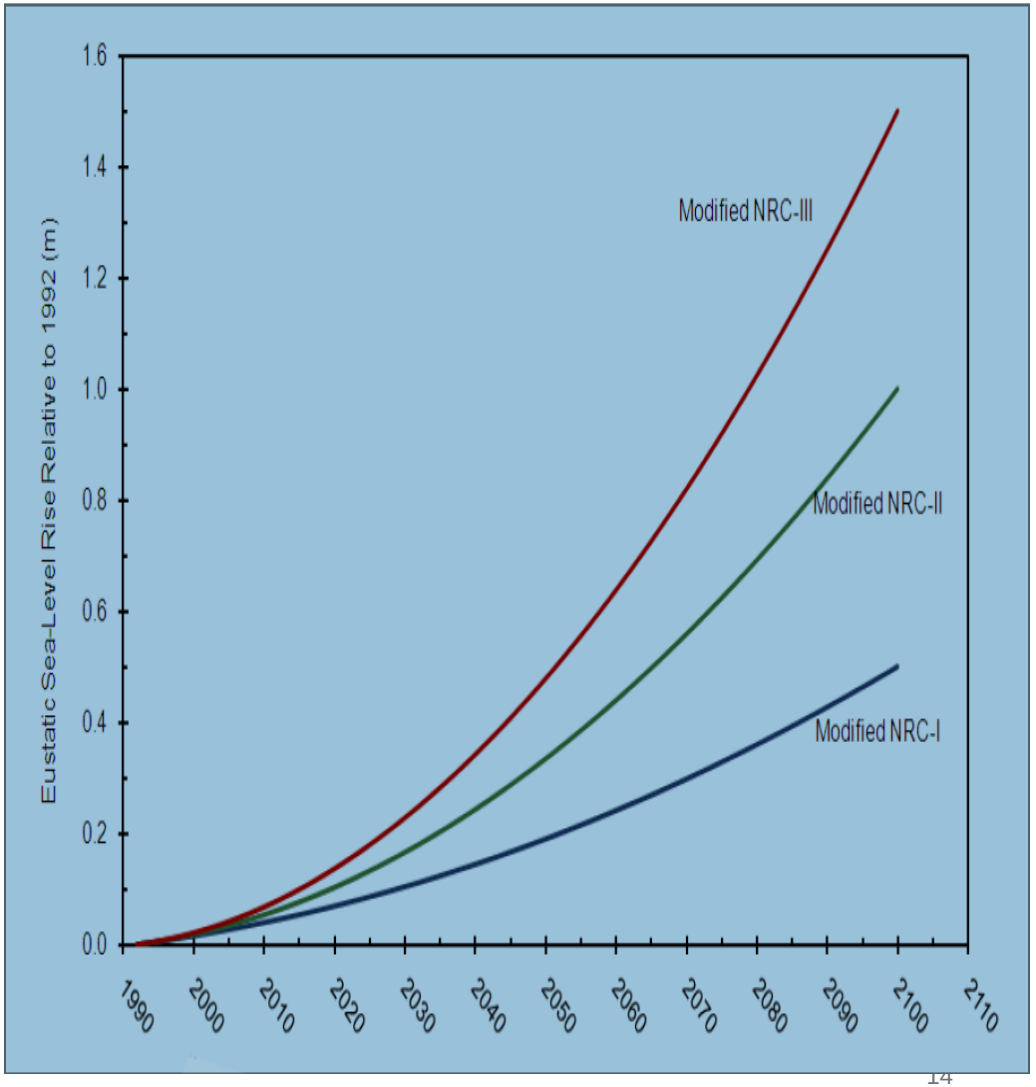


Figure 23.--All-season PMP (in.) for 6 hr 200 mi^2 (518 km^2).

Sea Level Rise

- "… it is reasonable to assume that a credible upper-bound for 21st century GMSL (global mean sea level) rise would be about 2 meters. This by no means suggests that 21st century GMSL rise cannot exceed 2 meters, but a maximum of 2 meters is reasonable at this time." Corps Circular 1165-2-212 (1 October 2011)



Conclusions

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- Embrace the Uncertainty
  - Probabilistic Flood Hazard Assessment
  - Future conditions uncertainty
  - Minimize future regrets
  - Increase adaptive capacity
- Trust but Verify Climate Projections
  - Continuous improvement in data and methods