# Levee Performance and Floodplain Risk Analysis with HEC-WAT

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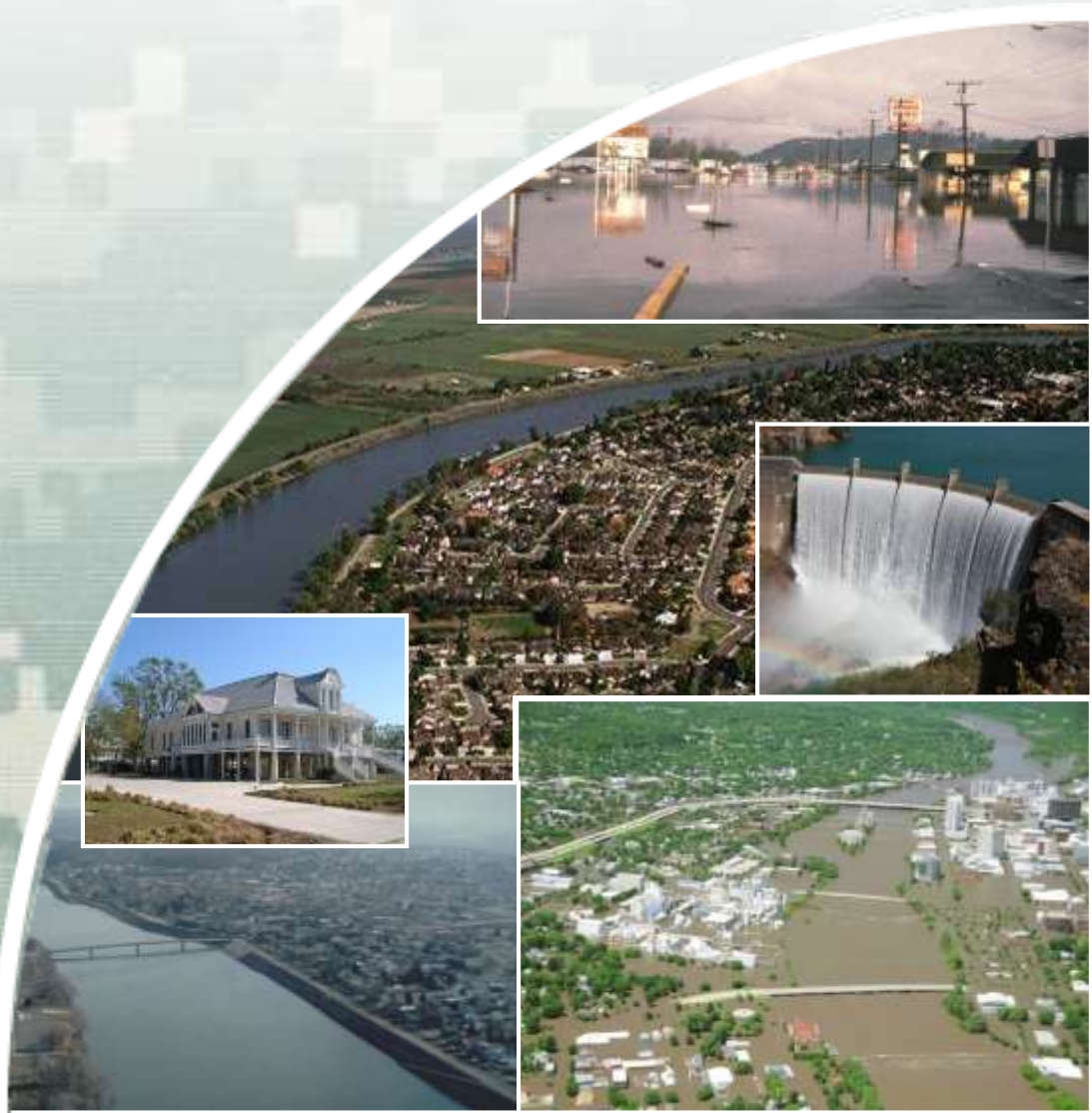

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# Topics

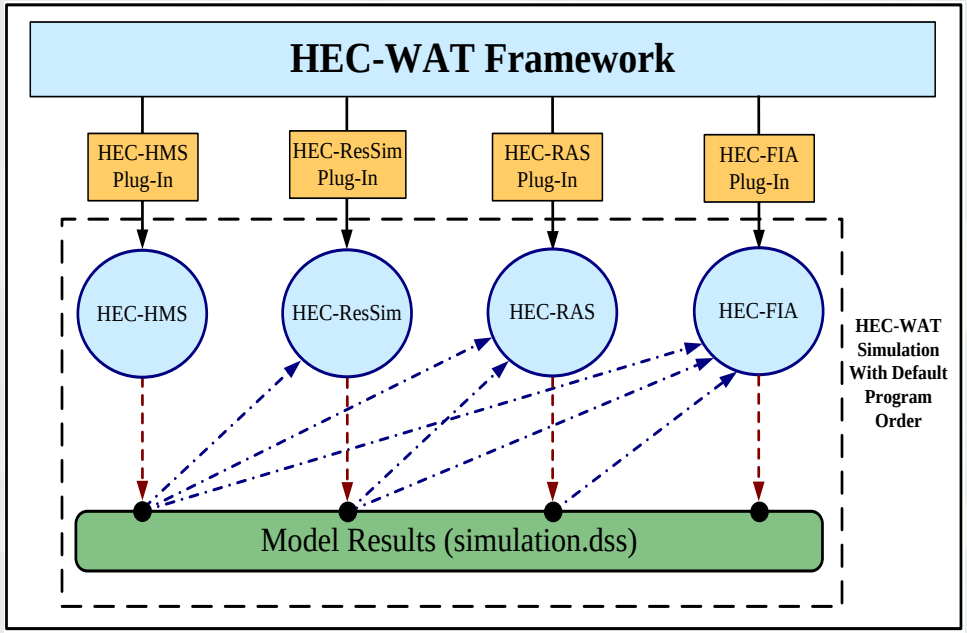
- HEC-WAT Background
- Compute Options – Deterministic and Flood Risk Analysis
- Demonstration Study – Natomas Basin
- HEC-WAT Results – New Levee Certification Metric
- Questions

# What is the WAT?

A water resources tool that integrates engineering and consequence software applications to support a wide range of studies, including watershed and systems-based risk analyses.

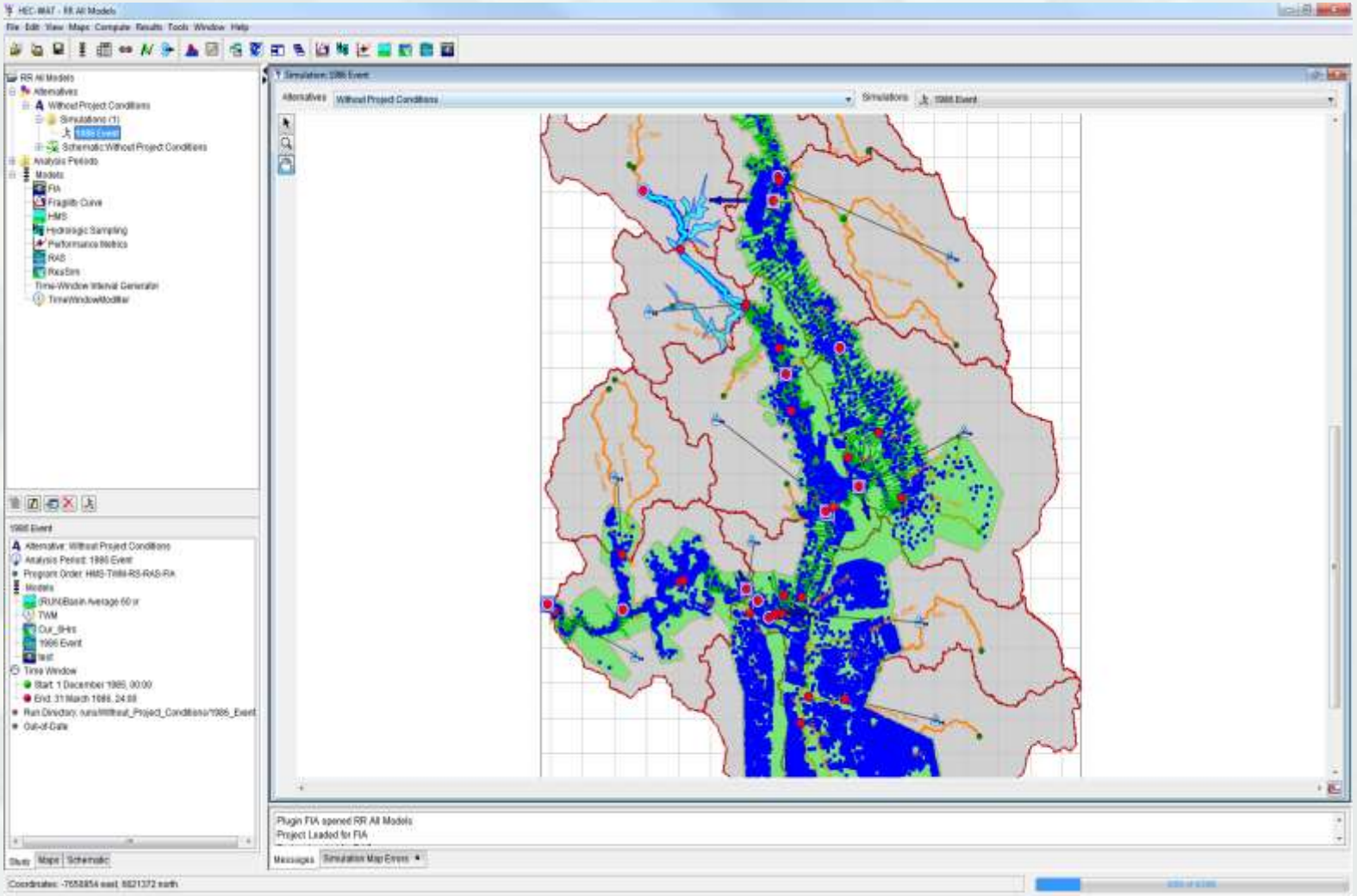
# HEC-WAT Model Integration

- Models and tools used during the analytical process
  - Hydrology - *HEC-HMS*
  - Reservoirs - *HEC-ResSim*
  - Hydraulics - *HEC-RAS*
  - Economics - *HEC-FIA*




- Communication is provided via plug-ins
- Share data across models with a common HEC-DSS file and other model results

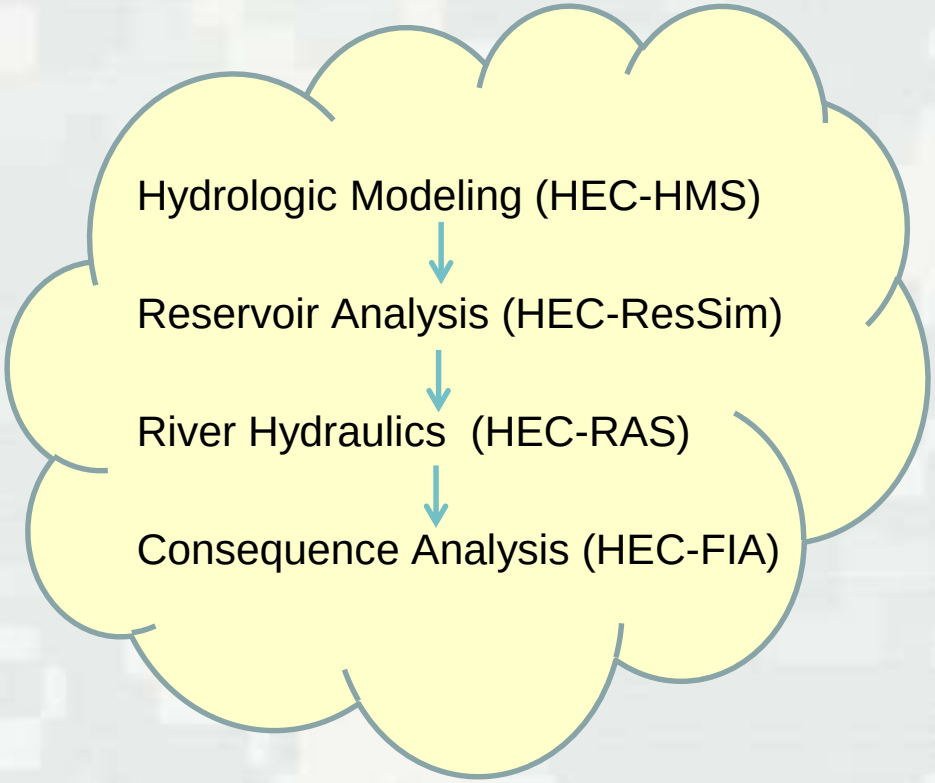
# Development of an HEC-WAT Model



- HMS Models
- ResSim Models
- RAS Models
- FIA Models

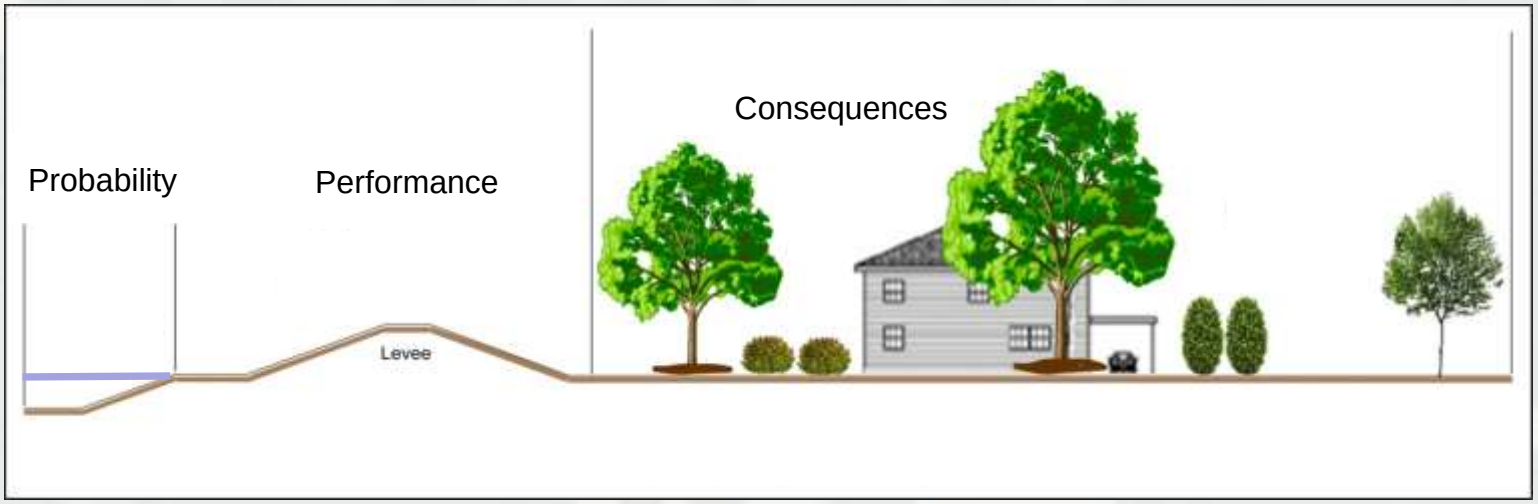
# Deterministic Compute

- Single Flood Event
  - Example: January 8 1986 to January 13 1986
  - Simplest type of compute
  - Eliminates manual handoffs between models
- Period of Record
  - Example: October 1 1943 to September 30 2014
  - Slightly more complex compute



# Risk Analysis

- ER 1105-2-101 says *"All flood damage reduction studies will adopt **risk analysis**…"*
- Risk = Probability x Consequences (x Performance)




- Uncertainty represents the imprecision of parameters and mathematical functions used to describe the hydraulic, hydrologic, geotechnical, and economic aspects of a project plan.

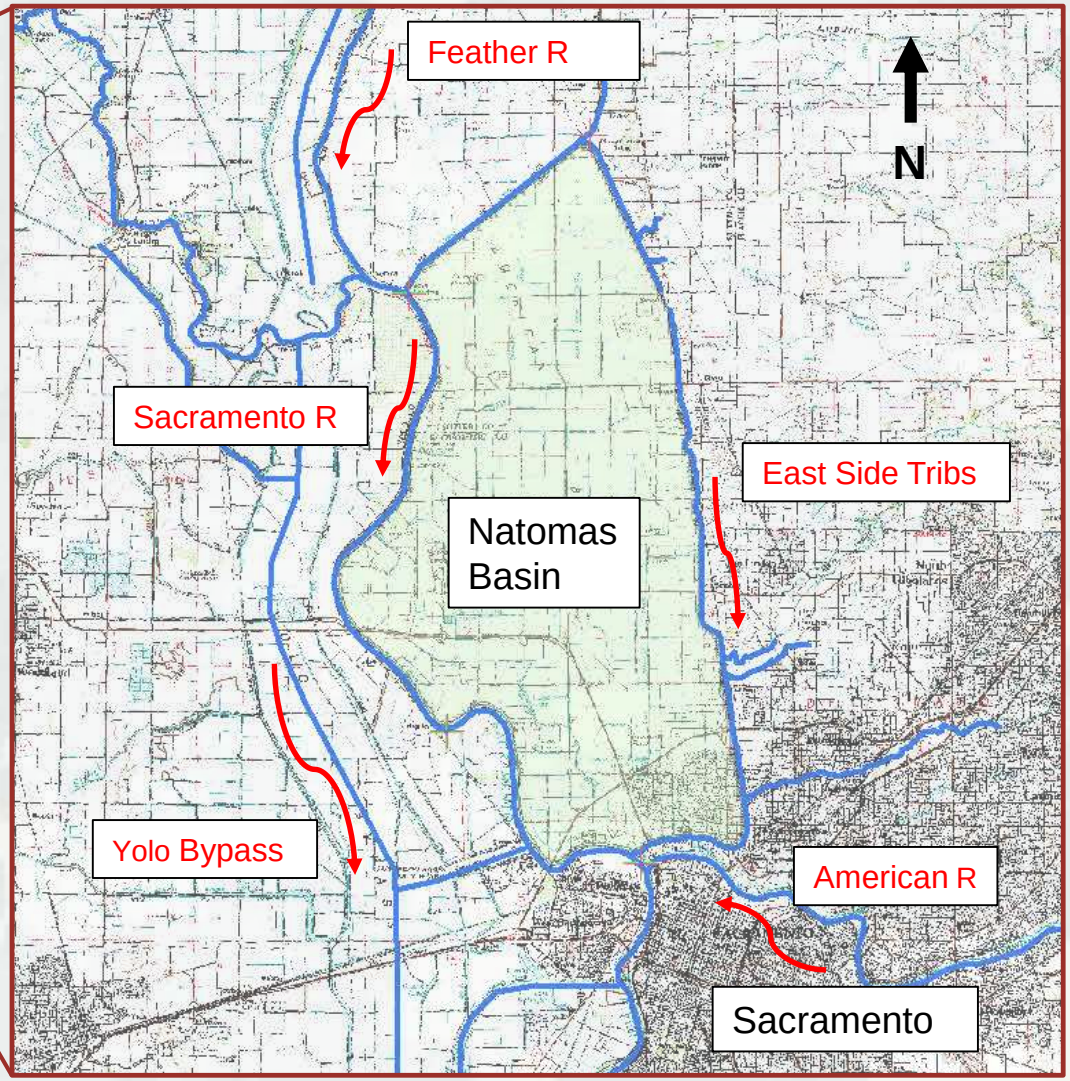
# Flood Risk Analysis Compute

- FRA compute uses a Monte Carlo style compute to support risk analyses.
- Individual applications sample model parameters from a range of values to capture uncertainty.
- Natural variability and knowledge uncertainty sampled separately.


inner loop A varies natural variability, computes events

outer loop B varies knowledge uncertainty, computes distribution

# Demonstration Study Location

# New Levee Certification Metric

- Greater USACE-FEMA collaboration
- USACE levee certification metrics have changed over time
  - Freeboard
  - Conditional Non-Exceedance Probability of 1% Event
  - Now, Assurance that Annual Exceedance Probability is < 1%

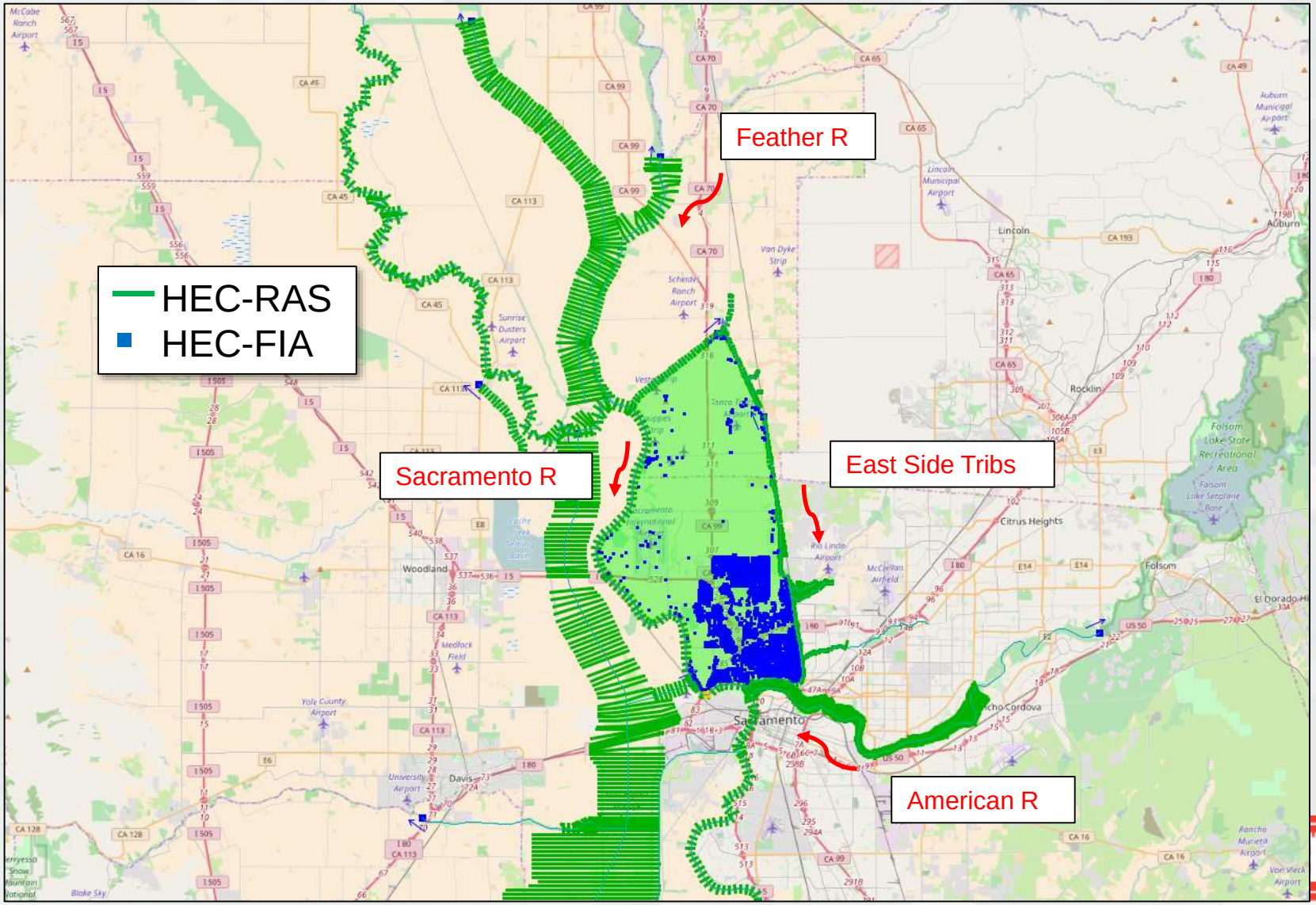
# Why a New Metric?

- Consider floods AND levee performance
- Assess all possible floods (not just 1% event)
- Include uncertainty

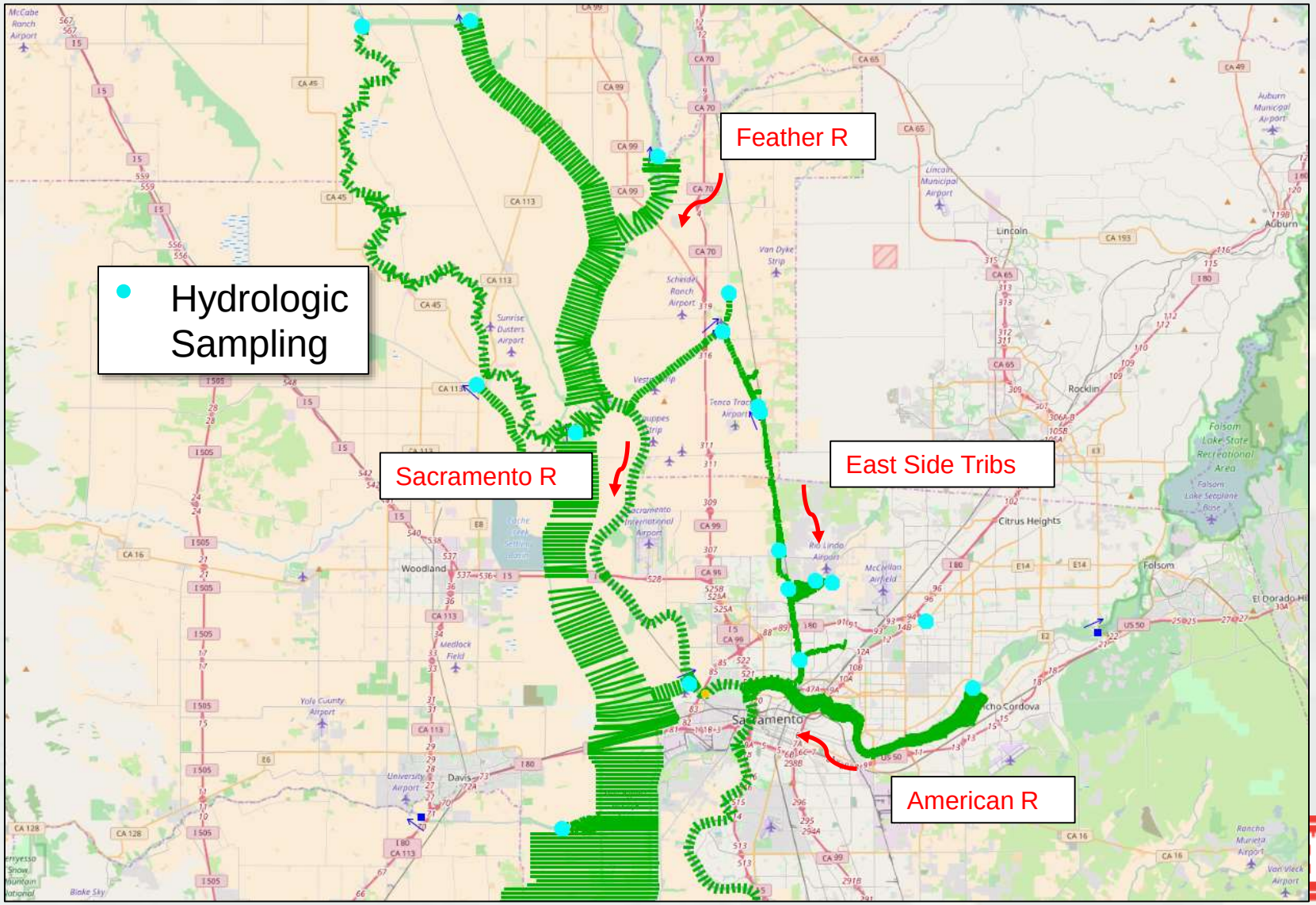
# Demonstration Study Setup

- HEC-RAS and HEC-FIA study models
- FRA compute to evaluate levee performance and floodplain risk
- 50,000 events, broken into 100 realizations (knowledge uncertainty) of 500 events (natural variability)
- New flow frequency curve sampled for each realization (KU)
- Hydrology and levee breach trigger elevation sampled for each event (NV)

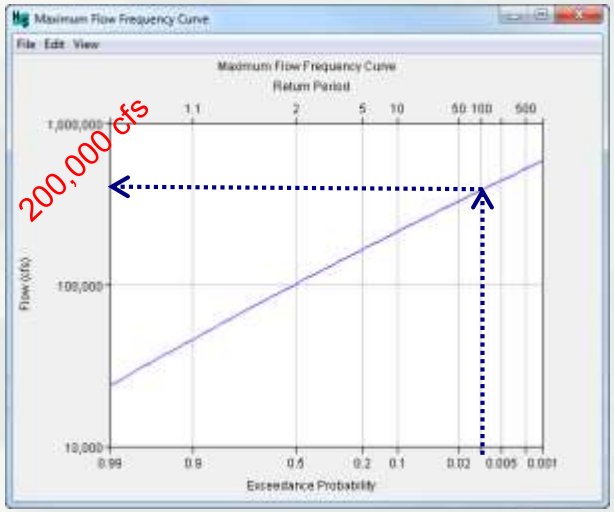
# Study Models



# Flow Sampling



# Hydrologic Sampling

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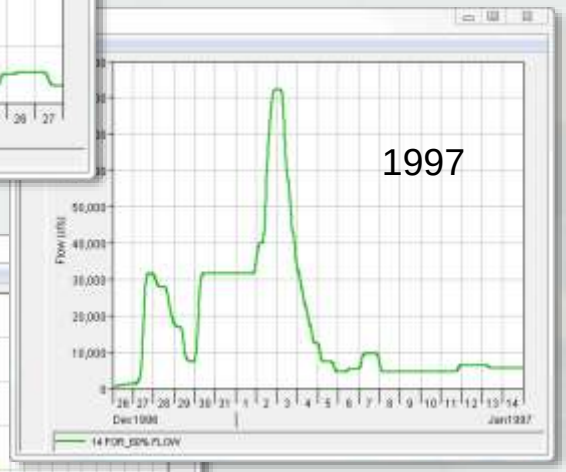
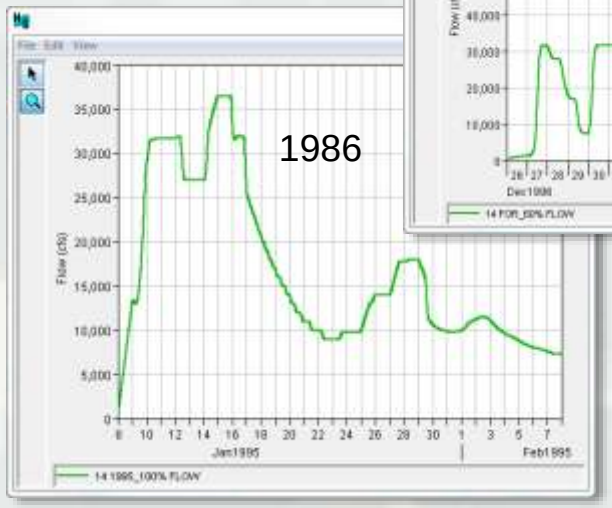
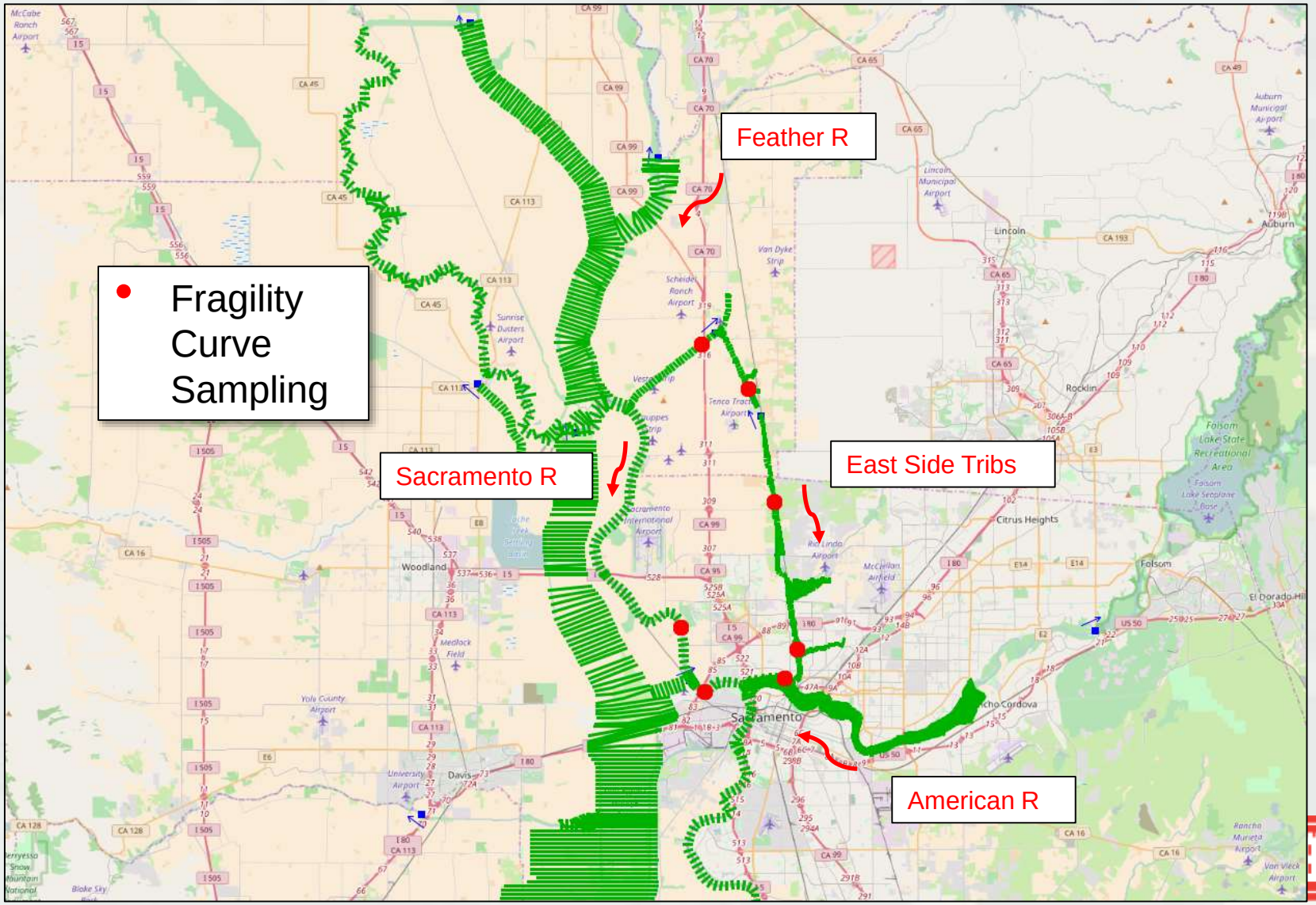


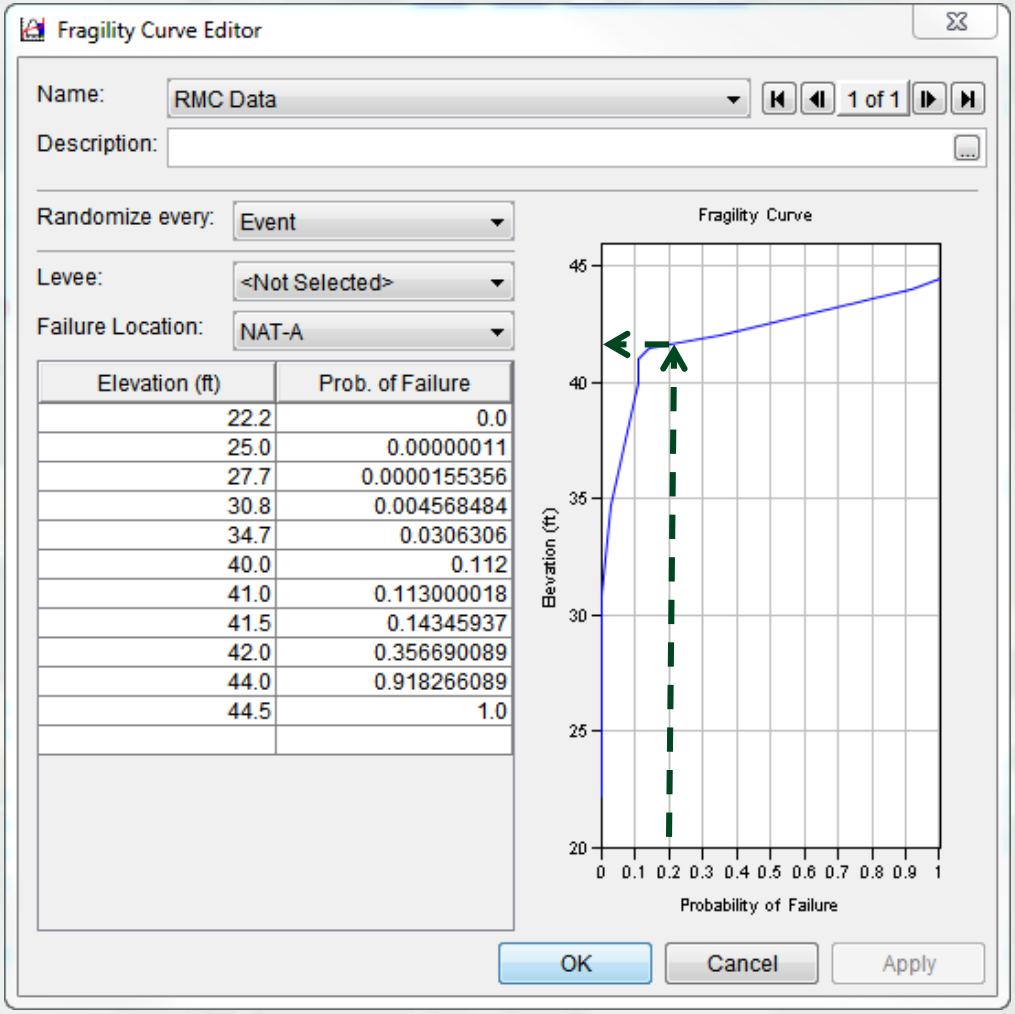




**Random choice of probability U[0,1] to "generate" event**

# Potential Breach Locations



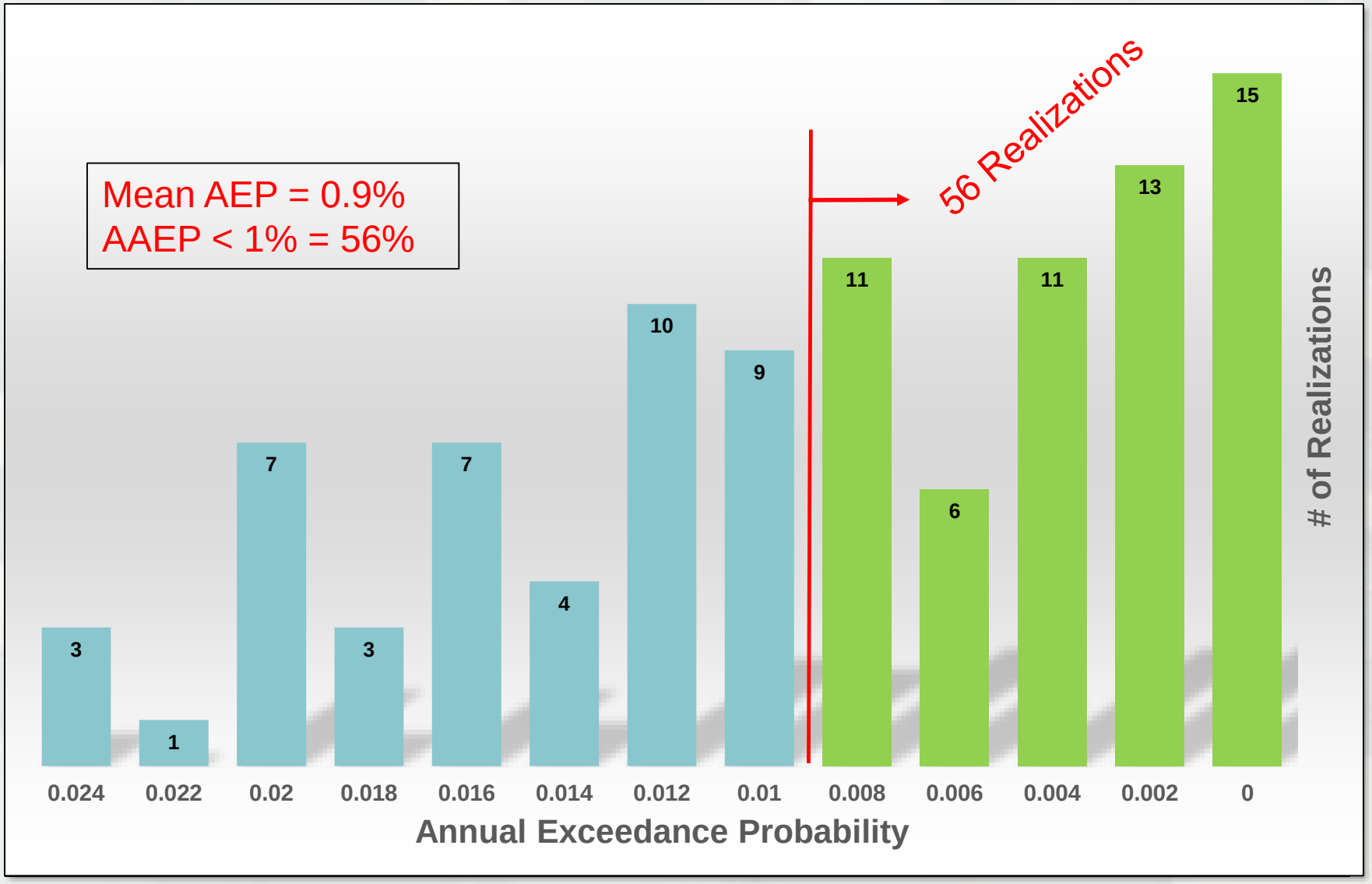
# Levee Fragility Curves




Random Seed: 0.20

Failure Trigger Elev: 42.1 ft

# Results – Annual Exceedance Probability



# Key Take Aways

- HEC-WAT provides systems-based and flood risk analysis capabilities
- HEC-WAT can be used to evaluate the new levee certification metric under development: Assurance that AEP is < 1%

# QUESTIONS?

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