Evaluating Flood Hazards in the TVA System

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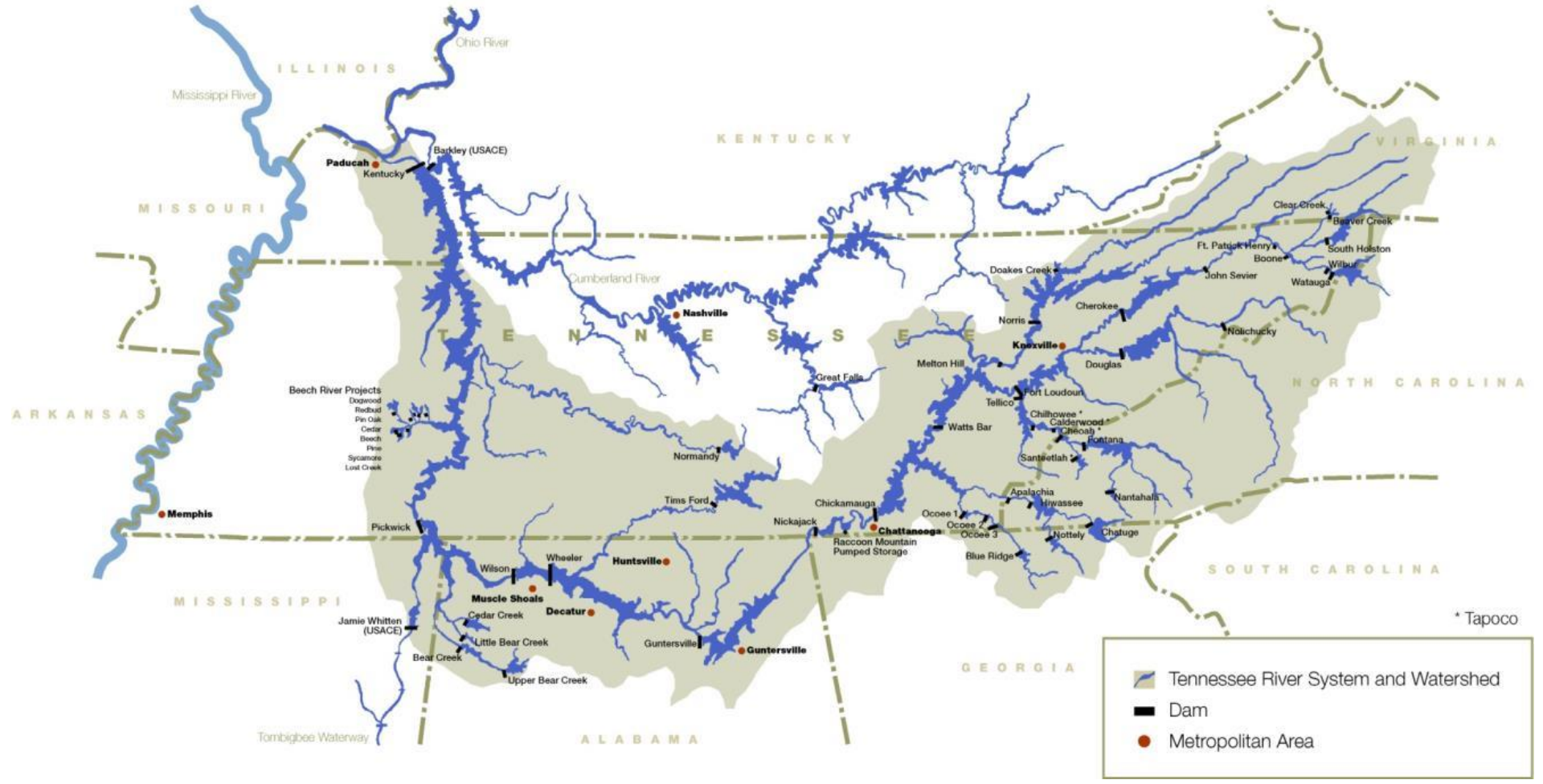
Tennessee River System



Multipurpose Water Management Goals

Navigation
- Provide 652 miles of navigable waterway
- >$1B/yr economic benefit

Water Supply
- Maintain levels for >700 intakes

Flood-Damage Reduction
- Reduce damages ~$250M/yr

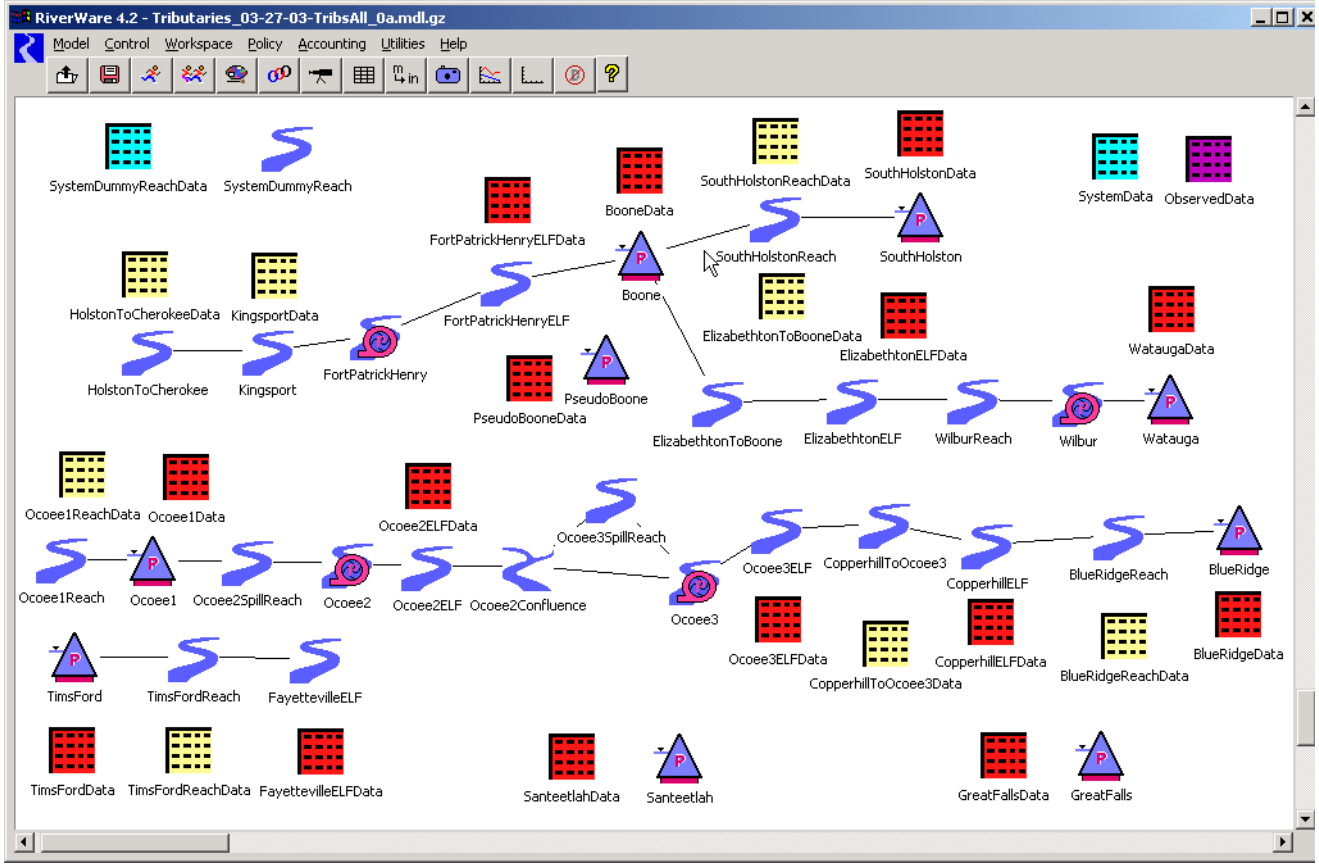
Recreation
- Provide suitable levels and flows for reservoir & rivers
- $1B/yr economic impact
- Draw to the valley

Power Generation
- ~$600M/yr of cheap & clean energy
- Considerable peaking and ancillary services

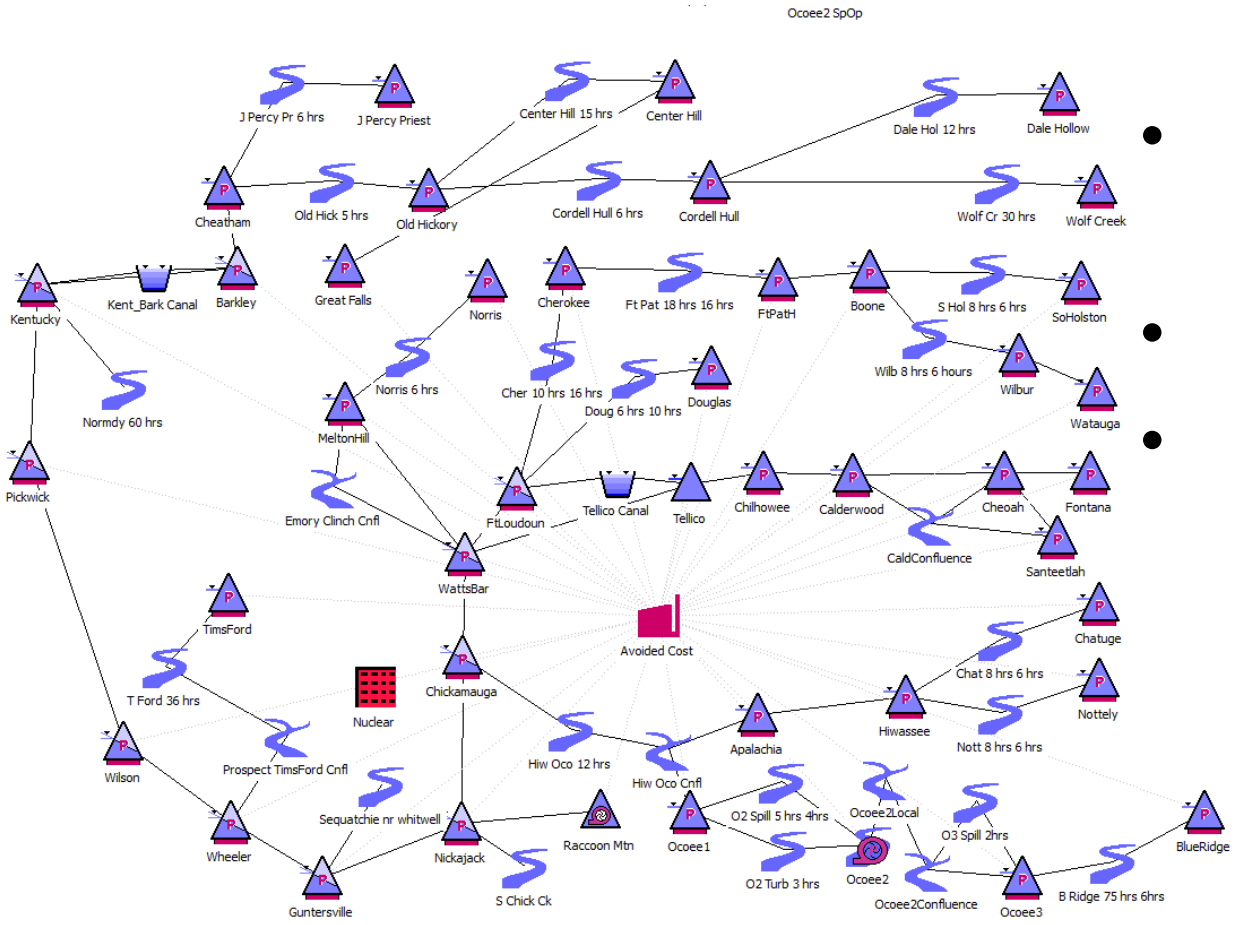
Water Quality
- Provide min flows for habitat and assimilation
- Manage temperatures for thermal plants
- Manage dissolved oxygen

RiverWare Models - ROS

- ROS
  - Planning model
  - Built by Riverside in 2003/2004
  - Segmented in time and space due to computing limitations

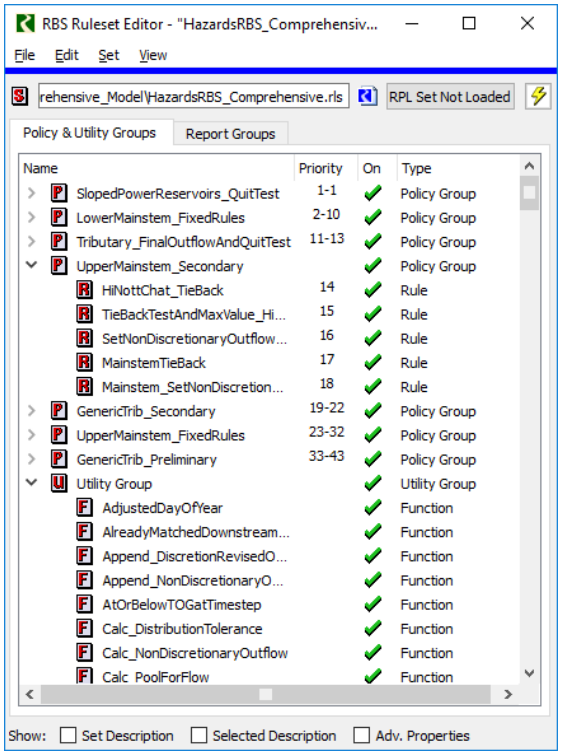


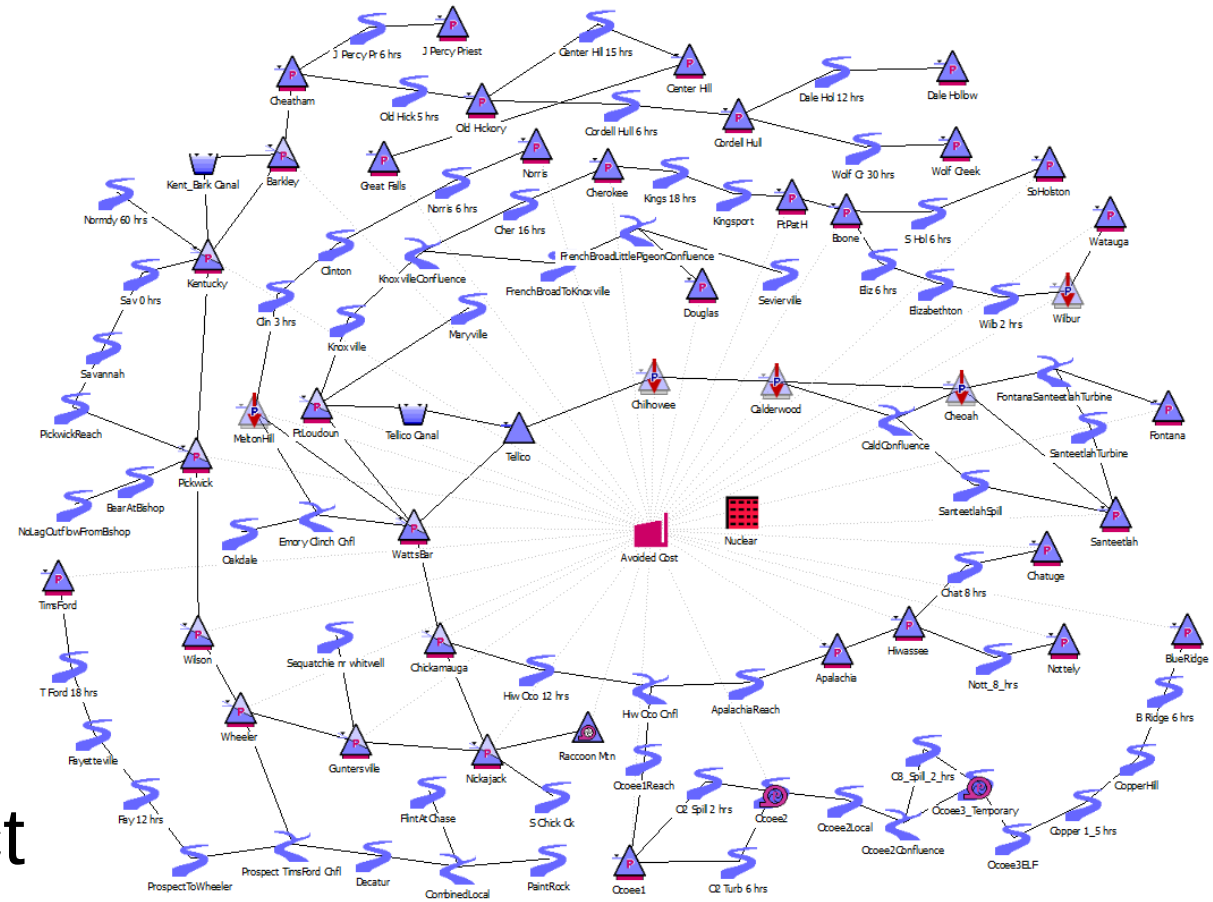
RiverWare Models - Operational



- Used currently by TVA
- Optimization
- Limited functionality for high flows

RiverWare Models – Hydrologic Hazards

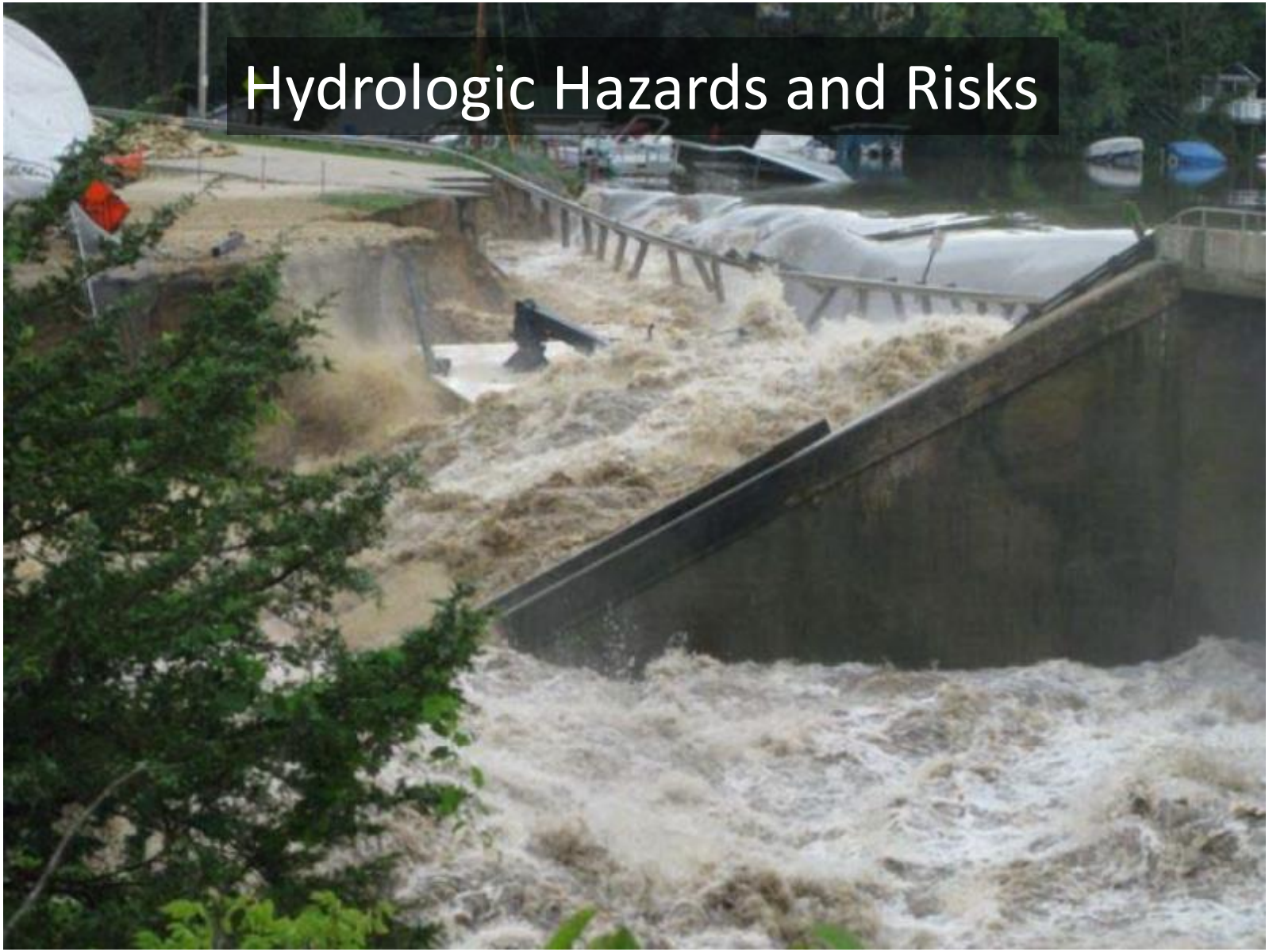




- Current project
- ROS rules (modified)
- Operational model structure and objects (modified as needed)

Work Done on Model

- Update ROS model from RiverWare version 4.4 to 6.9
- Consolidate segmented ROS model into single new model
- Update rules to match current operations
  - Changes to flood and recovery modes
  - Simplified some rule logic

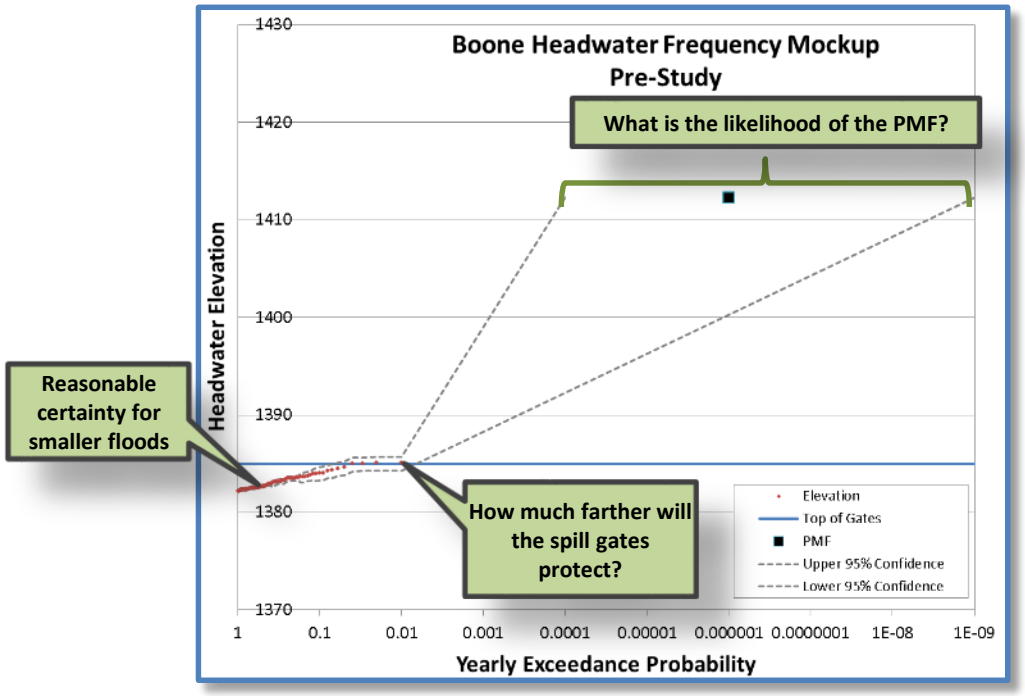

Hydrologic Hazards and Risks

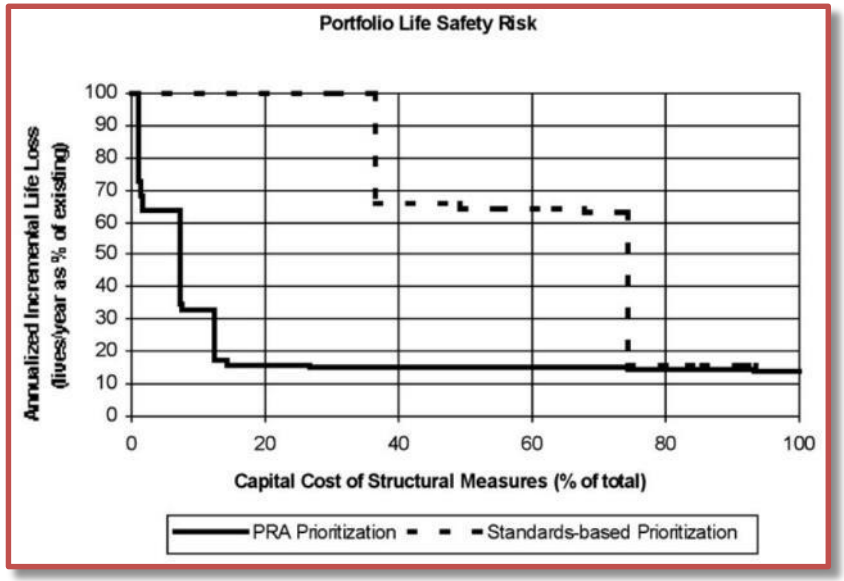
Risk

- Flood risk across TVA?
  - Risks affecting multiple projects
  - System risk reduction alternatives
- Stochastic Flood Simulation
  - Natural hydrologic processes
  - Reservoir operation
  - Simulation process is easy to understand and validate – mimics reality
  - A natural platform to add dam safety risk analysis:
    - Failure modes, gate reliability, breach modeling and consequences
  - Inputs to Risk Informed Decision Making

Risk

- Determine probabilities for events between historical record and PMF
- Prioritize risk reduction efforts effectively



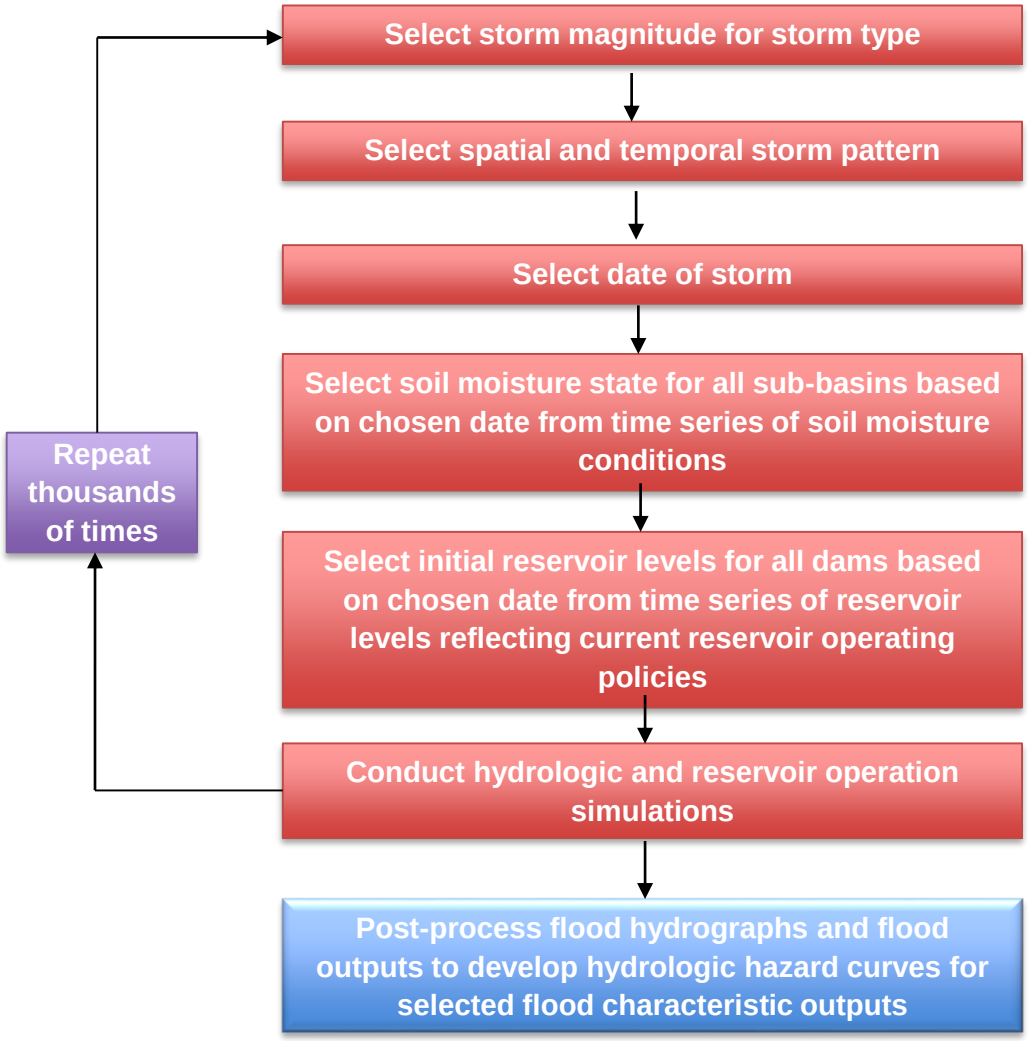


Stochastic Flood Simulation Approach

- Baseline run
  - 1000 years
- Precip record created from actual data
- Carefully sampling wet/dry periods maintains realism
- Run precip through hydrologic models to get inflows and soil moisture states
- Process inflows using RiverWare

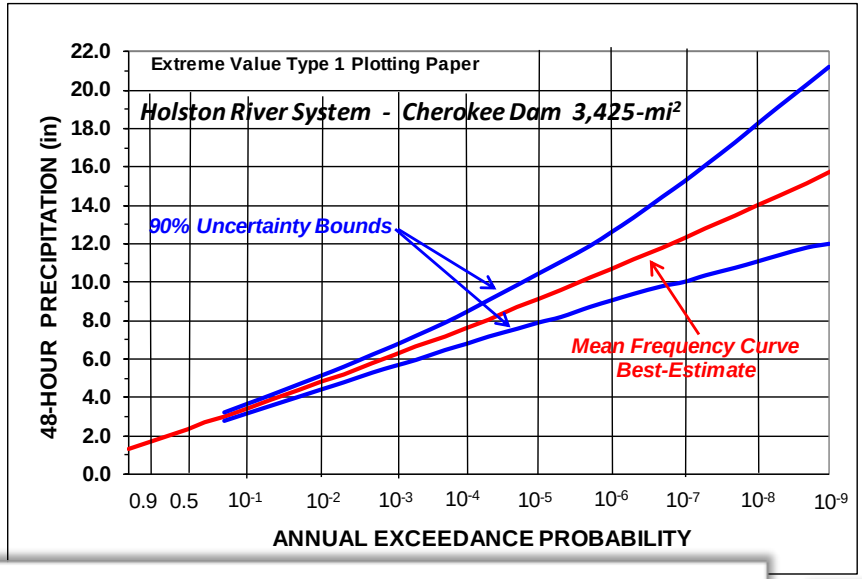
Stochastic Flood Simulation Approach

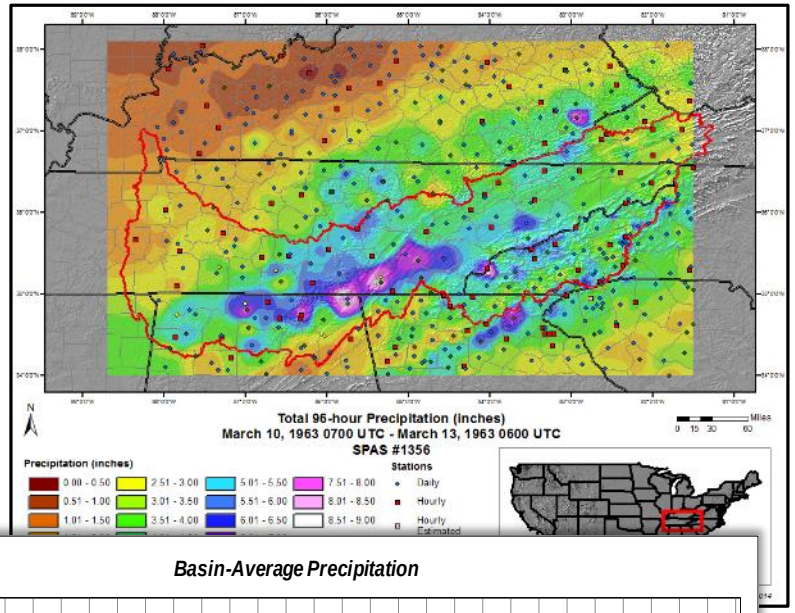
- Simulate real storms, watershed response, and reservoir system response
- Repeat ten of thousand times, compute statistics from results
- Each simulation mimics response to real events

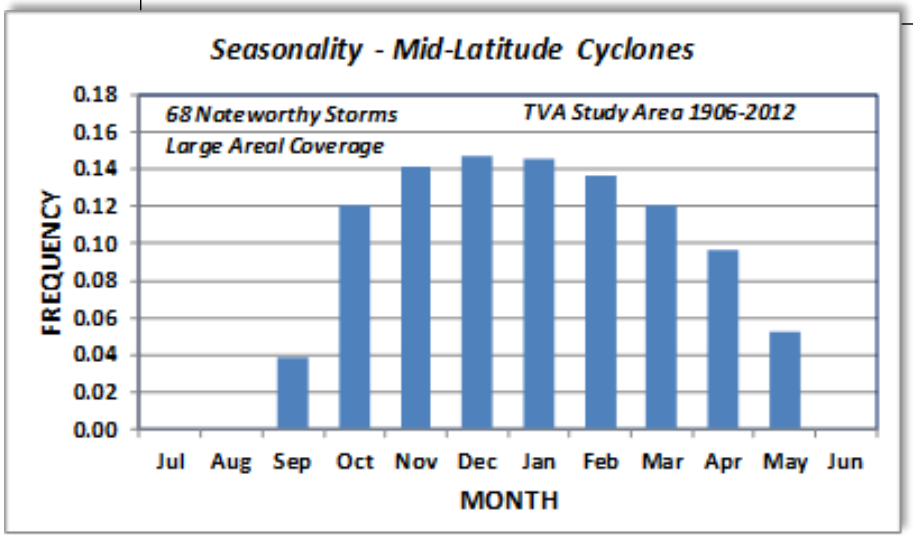


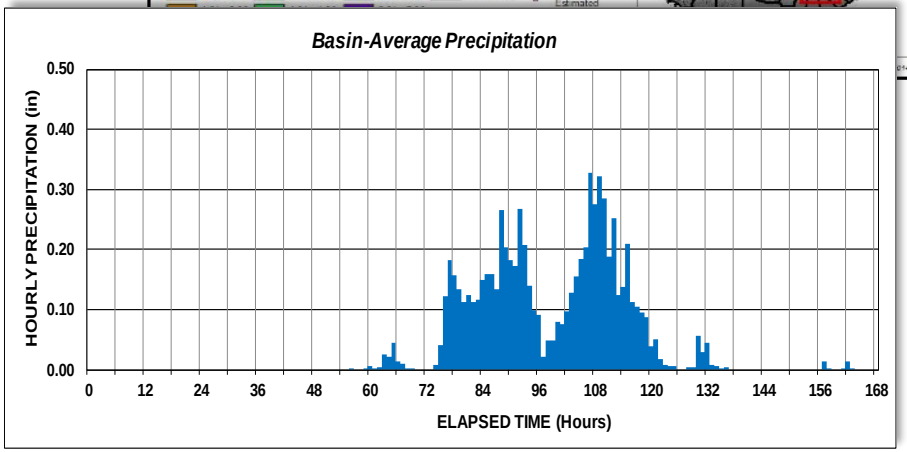
Stochastic Flood Simulation Approach

- Precipitation sampling per simulation









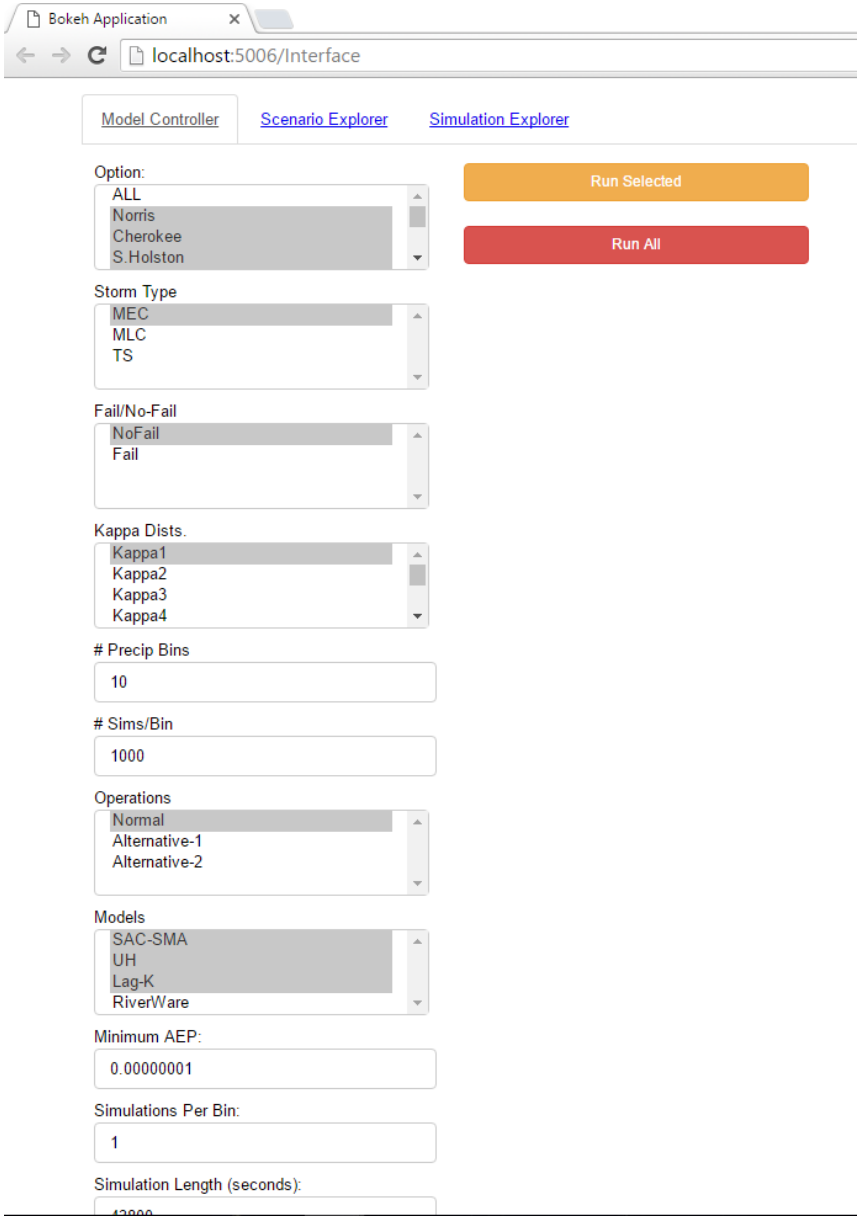
Stochastic Flood Simulation Approach

- Run SEFM
  - Developed by MGS Engineering

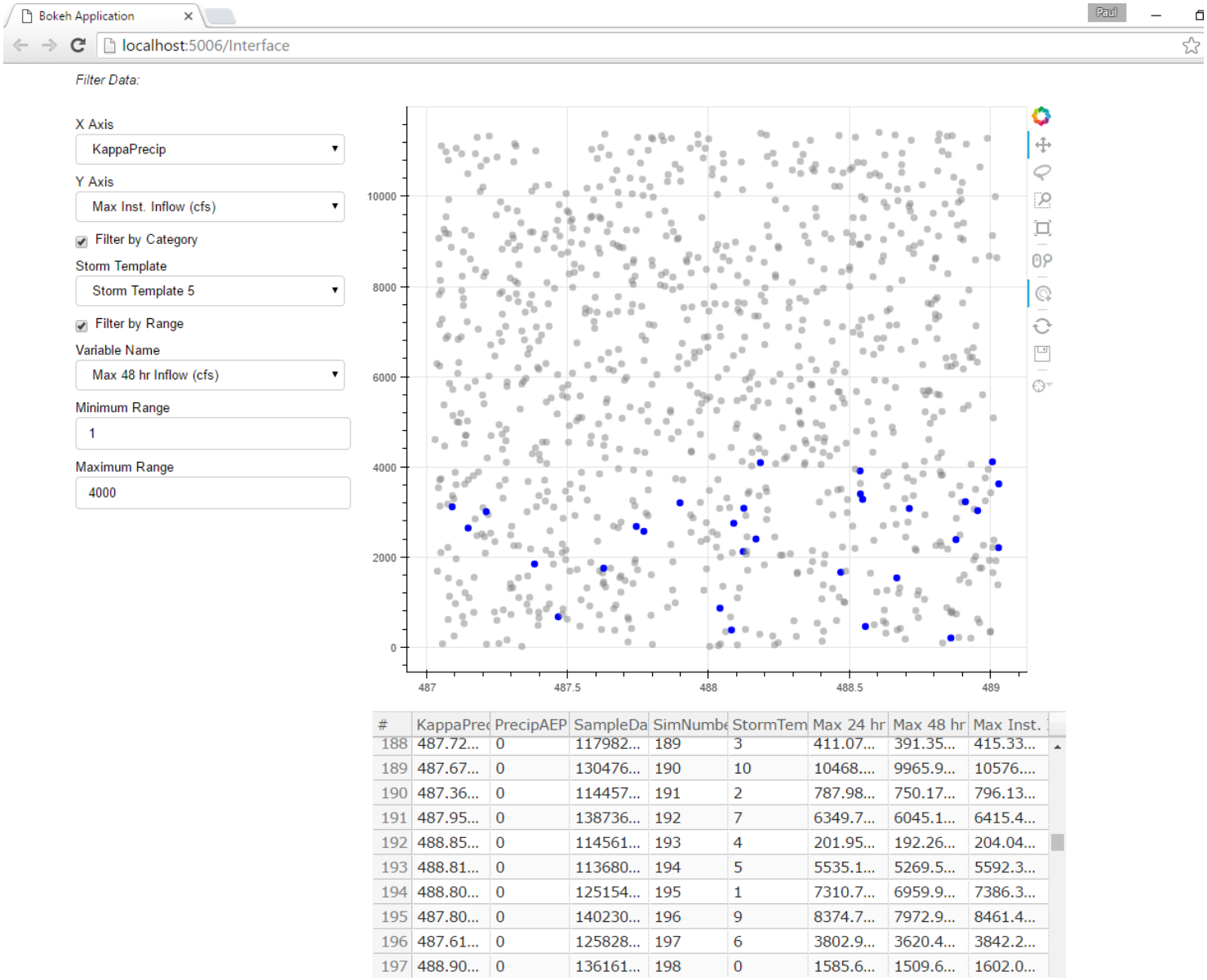
    MGS Engineering Consultants, Inc.
  - Sample precip
  - Run hydrologic models (based on NWS models)
- Route flows to reservoirs
- Run RiverWare
- Analyze results

Stochastic Flood Simulation Approach

- Controlled through custom interface
- Allows selection of simulation options
- Run many many simulations

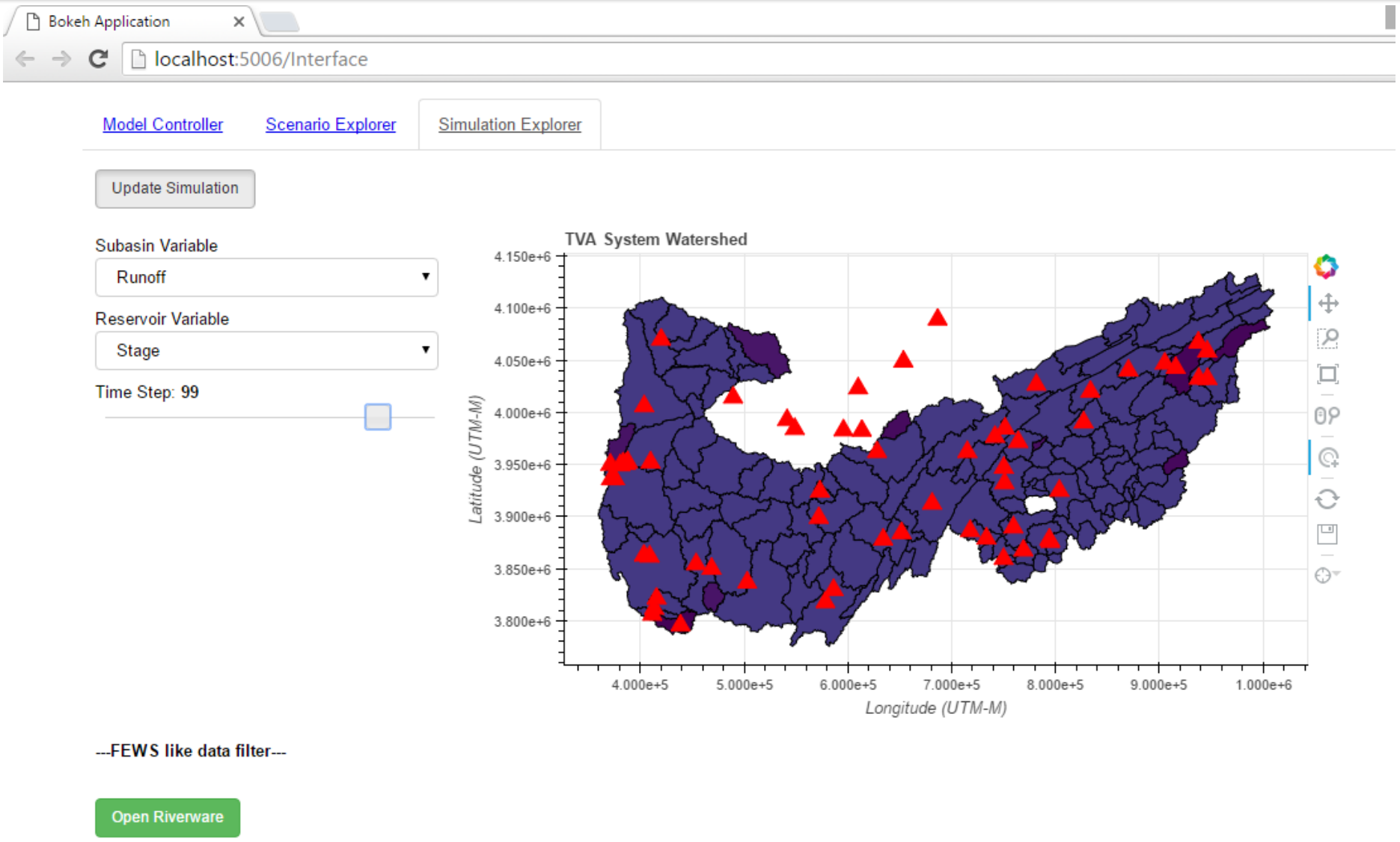


Stochastic Flood Simulation Approach



#	KappaPrec	PrecipAEP	SampleDa	SimNumbe	StormTem	Max 24 hr	Max 48 hr	Max Inst.
188	487.72...	0	117982...	189	3	411.07...	391.35...	415.33...
189	487.67...	0	130476...	190	10	10468....	9965.9...	10576....
190	487.36...	0	114457...	191	2	787.98...	750.17...	796.13...
191	487.95...	0	138736...	192	7	6349.7...	6045.1...	6415.4...
192	488.85...	0	114561...	193	4	201.95...	192.26...	204.04...
193	488.81...	0	113680...	194	5	5535.1...	5269.5...	5592.3...
194	488.80...	0	125154...	195	1	7310.7...	6959.9...	7386.3...
195	487.80...	0	140230...	196	9	8374.7...	7972.9...	8461.4...
196	487.61...	0	125828...	197	6	3802.9...	3620.4...	3842.2...
197	488.90...	0	136161...	198	0	1585.6...	1509.6...	1602.0...

Stochastic Flood Simulation Approach



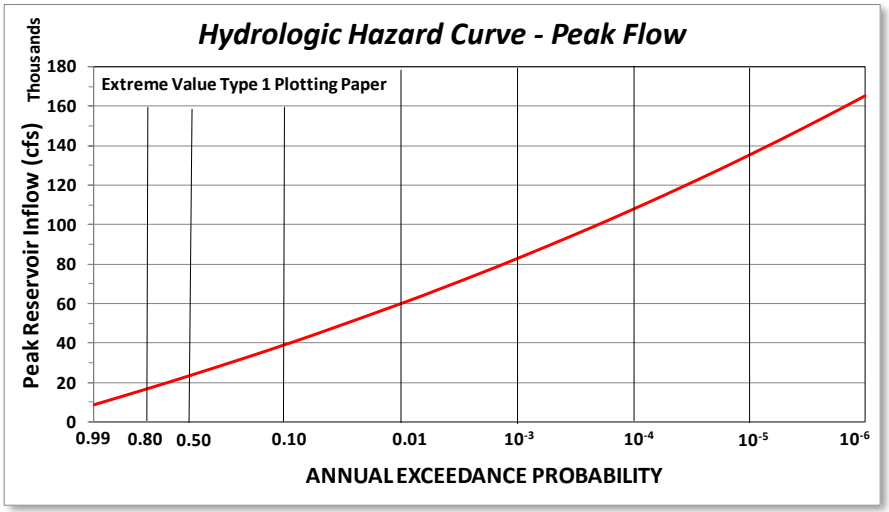
Stochastic Flood Simulation Approach

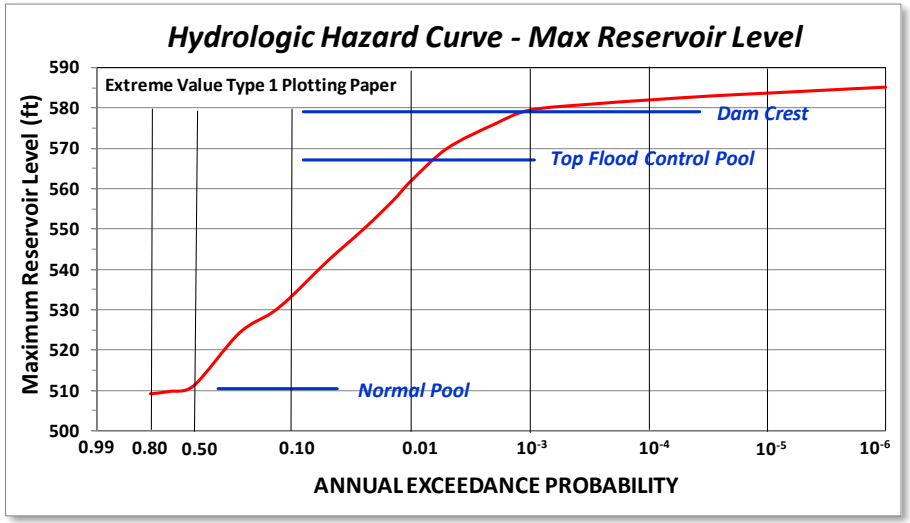
Future Work

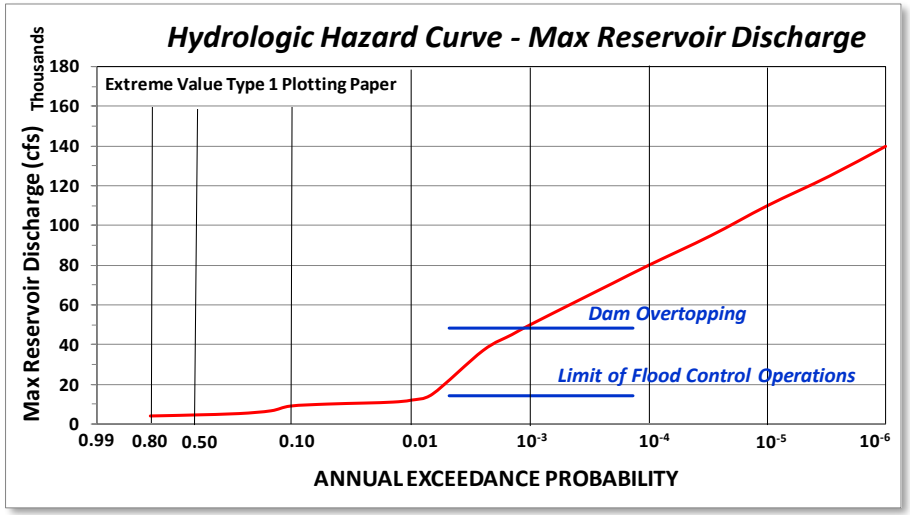
- Add failure into RiverWare
  - Gate failure
  - Blockages
  - Dam breaches?
- Perform risk calculations in RiverWare

Stochastic Flood Simulation Approach

- Approach to develop hydrologic hazard curves

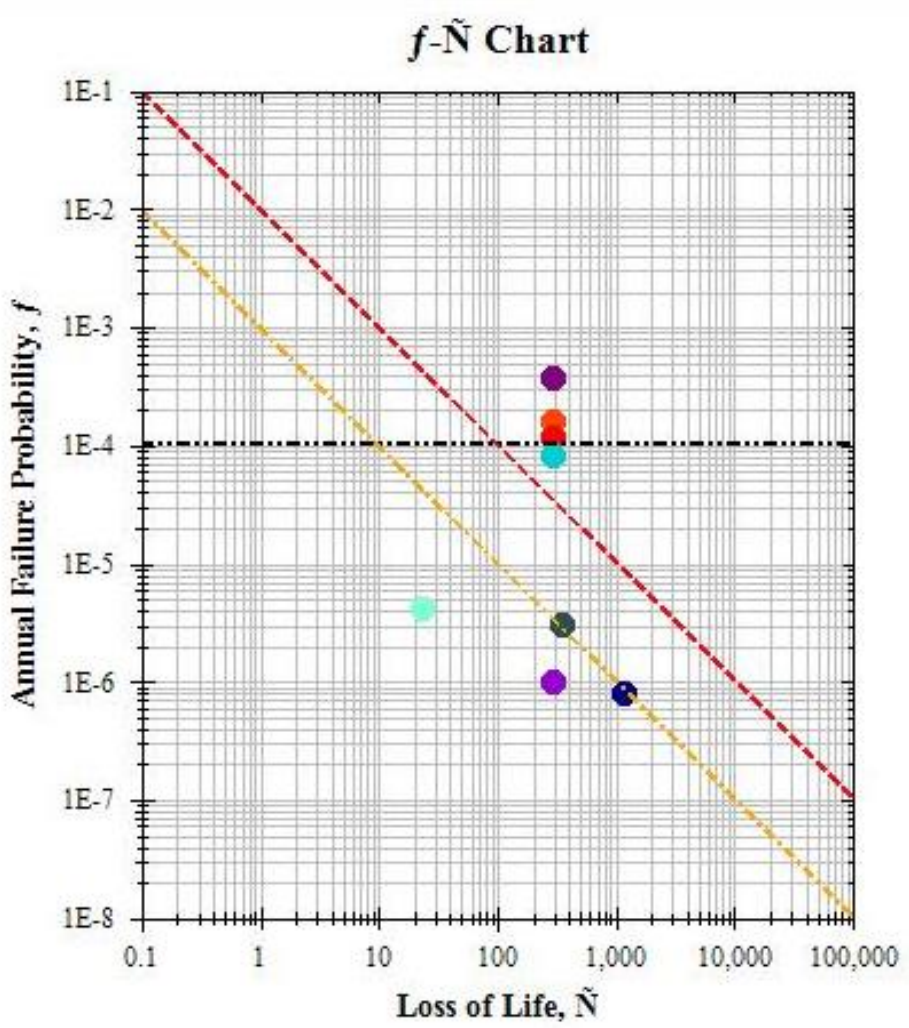






Stochastic Flood Simulation Approach

- Summary of results in standard f-$\overline{N}$ charts



Benefits

- Risk-informed decision making
  - Lower risk to life and property effectively and economically
- Easy to understand results – easy to validate
- Can be used for future planning studies
- Can be used in training for TVA River Operations staff

The End