



Future PFHA Research at NRC

Thomas Aird
Meredith Carr, Ph.D., PE
Mark Fuhrman, Ph.D.
Joseph Kanney, Ph.D.
Jacob Philip, PE
Elena Yegorova, Ph.D.

Fire and External Hazards Analysis Branch, Division of Risk Analysis
Office of Nuclear Regulatory Research

3rd Annual PFHA Research Workshop
NRC HQ, Rockville, MD
December 4-5, 2017

Expected NUREG/CR Completions in FY18

- **Guidance on Application of State-of-Practice Flood Frequency Analysis Methods and Tools (USGS)**
- **Technical Basis for Extending Frequency Analysis Beyond Current Consensus Limits (USBR)**
- **Research to Develop Guidance on Extreme Precipitation Frequency in Orographic Regions (USBR)**
- **Technical Basis for Probabilistic Flood Hazard Assessment – Riverine Flooding (PNNL)**
- **Quantifying Uncertainties in Probabilistic Storm Surge Models (USACE)**
- **Effects of Environmental Factors on Manual Actions for Flood Protection and Mitigation at NPPs (PNNL)**
- **Modeling Plant Response to Flooding Events (INL)**
- **Regional Climate Change Projections: Potential Impacts to Nuclear Facilities (PNNL)**

External Hazard Information Digest (INL)

- Flood hazard population expected complete FY18-Q2
- Expansion to support Process for Ongoing Assessment of Natural Hazard Information (SECY-16-0144; SRM-SECY-16-0144):

- Tool for collecting, aggregating, reviewing, and assessing information on an ongoing basis
- Other Hazards
 - Expanded flooding content
 - High Winds
 - Extreme Temp/humidity
 - Seismic

The screenshot displays the 'External Hazards Dashboard' interface. On the left, a 'Select Plants' sidebar lists various nuclear power plants with checkboxes. The main area shows detailed information for three selected plants: Brunswick 1, Calvert Cliffs 1, and Calvert Cliffs 2. Each plant card includes its docket number, region, type, vendor, location type, location, and licensee. Below this information, there are tabs for 'Recent' activities and reports, with buttons for 'FLOOD', 'HIGH WIND', 'EXTREME TEMP', and 'Snow/Ice Loads'. A mouse cursor is hovering over the 'Snow/Ice Loads' button. The interface is designed to provide a comprehensive overview of external hazards for each plant.

External Hazards Dashboard

Select Plants

Filters

- ☐ ARKANSAS 1
- ☐ ARKANSAS 2
- ☐ BEAVER VALLEY 1
- ☐ BEAVER VALLEY 2
- ☐ BRAIDWOOD 1
- ☐ BRAIDWOOD 2
- ☐ BROWNS FERRY 1
- ☐ BROWNS FERRY 2
- ☐ BROWNS FERRY 3
- ☒ BRUNSWICK 1
- ☒ BRUNSWICK 2
- ☐ BYRON 1
- ☐ BYRON 2
- ☐ CALLAWAY
- ☒ CALVERT CLIFFS 1
- ☒ CALVERT CLIFFS 2

Activities/Reports Across Selected Plants

View activity related reports, such as SDPs and FSARs by hazard for all currently selected (on dashboard) plants.

Recent

FLOOD HIGH WIND EXTREME TEMP

Brunswick 1

Docket: 325
Region: 2
Type: BWR
Containment Type: Mark I(C)
Vendor: General Electric
Location Type: Coastal
Location: Southport, NC (2 MI N of Southport, NC)
Licensee: Carolina Power and Light

Recent

FLOOD HIGH WIND EXTREME TEMP

Snow/Ice Loads

Seismic

Calvert Cliffs 1

Docket: 317
Region: 1
Type: PWR
Vendor: Combustion Engineering
Location Type: Coastal
Location: Lusby, MD (40 MI S of Annapolis, MD)
Licensee: Baltimore Gas and Electric

Recent

FLOOD HIGH WIND EXTREME TEMP

Calvert Cliffs 2

Docket: 318
Region: 1
Type: PWR
Vendor: Combustion Engineering
Location Type: Coastal
Location: Lusby, MD (40 MI S of Annapolis, MD)
Licensee: Baltimore Gas and Electric

Recent

FLOOD HIGH WIND EXTREME TEMP

FY18 – New External Projects and Internal Initiatives

Critical Review of Dam Risk Assessment State of Practice

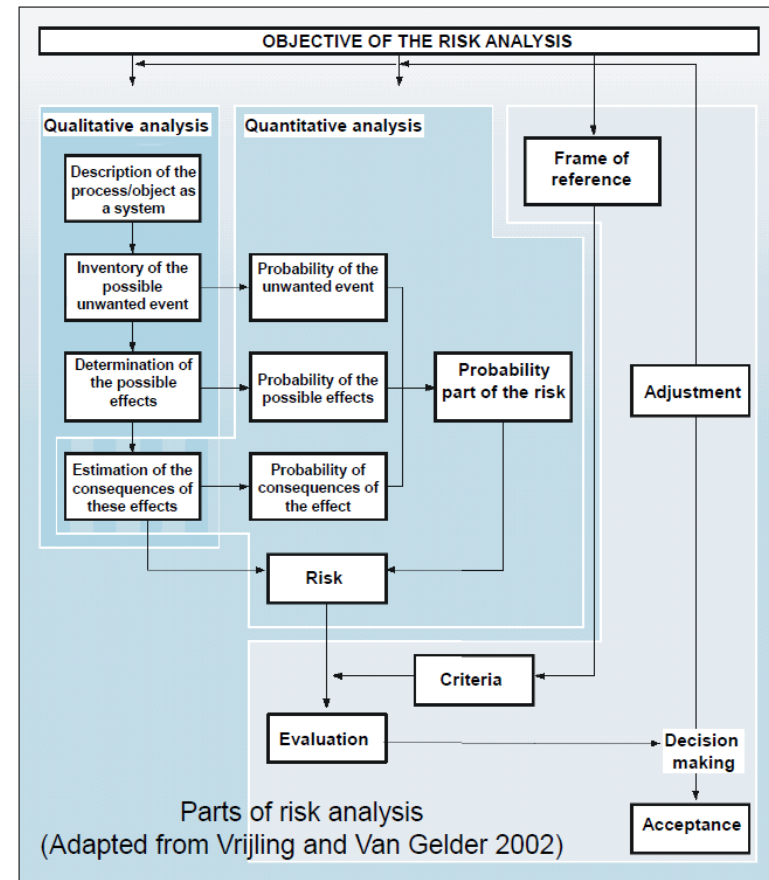
- *David Watson, Scott DeNeale, Brennan Smith & Shih-Chieh Kao (ORNL)*
- *Gregory Baecher (University of Maryland)*
 - *NRC PM: Carr*
 - *Project Timeline: Sept 2017 to Apr 2019*

Objective

Develop technical basis for guidance on application of state-of-the-practice approaches, methods and tools for dam risk analysis to inform assessment of flood hazards due to dam failure.

Scope

Assess methods for characterizing and quantifying key uncertainties, as well as propagating these uncertainties through the risk analysis procedure to support risk-informed decision-making



Critical Review of Dam Risk Assessment State of Practice

Key Tasks

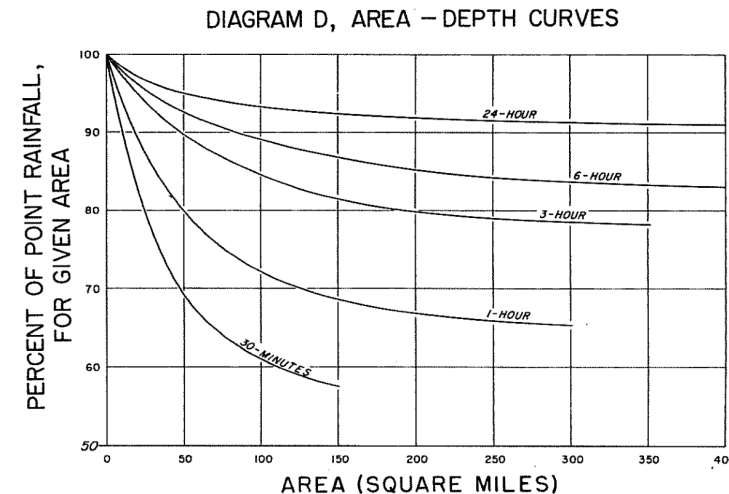
- Conduct workshop with federal agencies, academic researchers and private industry to review current state of practice in dam risk analysis
- Summarize current state of practice with focus on development of fragility information for
 - key components
 - control systems
 - operational procedures
- Review key process uncertainties, their characterization, and the degree to which they are propagated in state of practice approaches



Application of Point Precipitation Frequency Estimates to Watersheds

- *Shih-Chieh Kao, Scott DeNeale (ORNL)*
 - *NRC PM: Yegorova*
- Project Timeline: Oct 2017 to May 2019
- Current precipitation frequency products (e.g., NOAA Atlas 14) are mostly developed for point rainfall
- Areal reduction factors (ARFs) are needed to convert these point precipitation estimates to watershed estimates for H&H modeling
- ARFs in common use suffer from several key deficiencies:
 - Limited/outdated data
 - Small area sizes (up to 400-mi²)
 - Do not vary with location, return period, or season

Example ARF curves (from TP-29)



Source: Technical Paper No. 29; noaa.gov

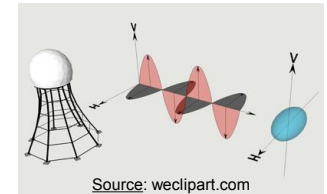
Application of Point Precipitation Frequency Estimates to Watersheds

Project Objectives

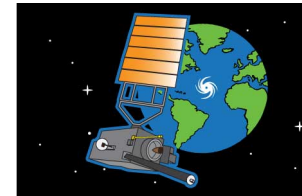
- Provide a summary of available precipitation products that can be used to develop point to area conversions of precipitation frequency estimates.
- Provide a critical review of available point to area conversion methods with a view to addressing the deficiencies in the commonly used empirical methods.
- Demonstrate use of the most promising method/dataset combinations through selected test cases.
- Support the development of future PFHA guidance on ARF



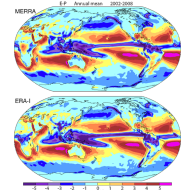
Source: monitorsensors.com



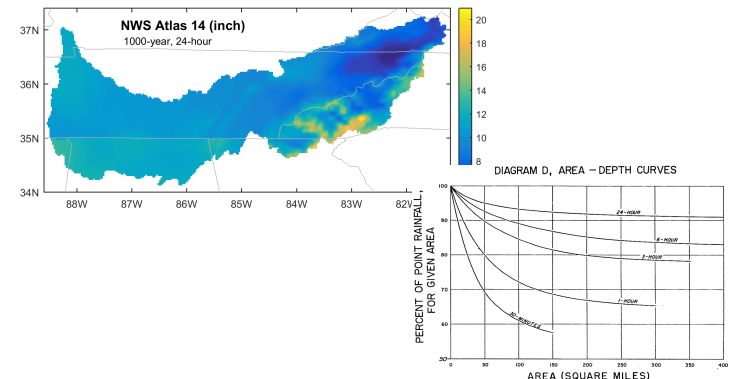
Source: weclipart.com



Source: nasa.gov

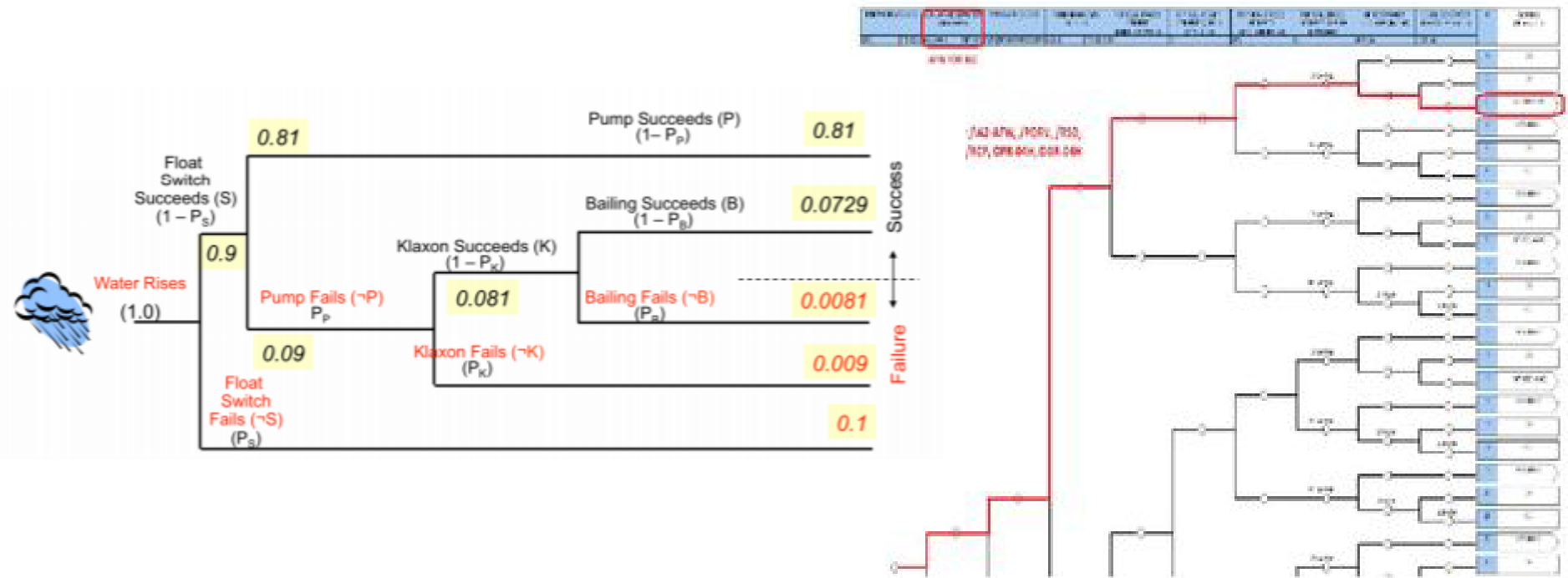


Source: ucar.edu



Interfacing Flood Hazard Modeling Outputs with HRA and PRA Models

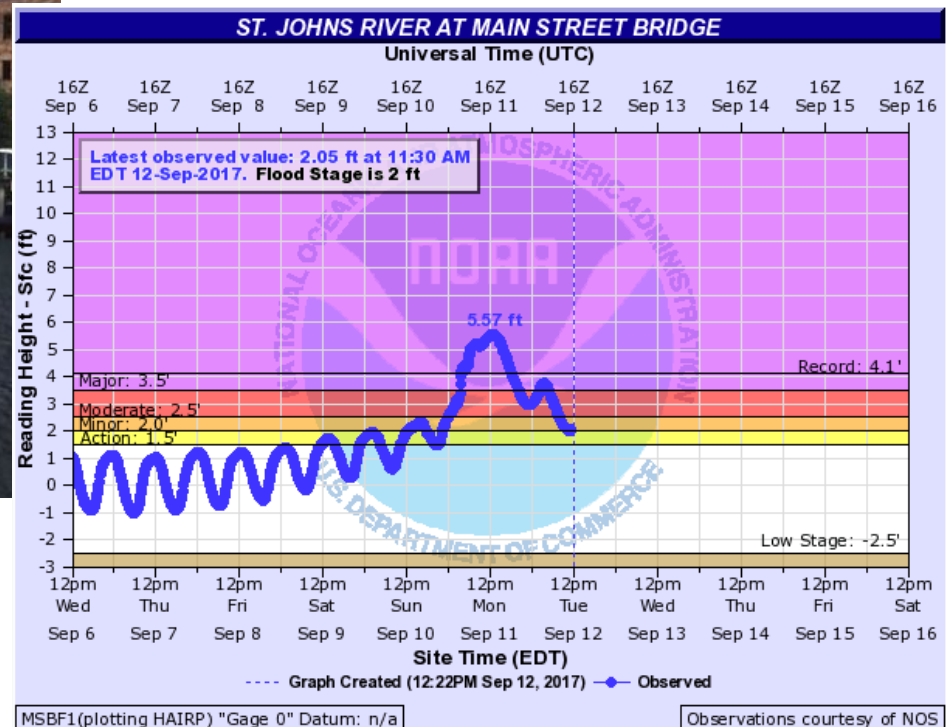
- Integrate flood hazard into existing models
- Determine important scenarios
- Handle time dependencies (phasing)
- Internal Collaboration



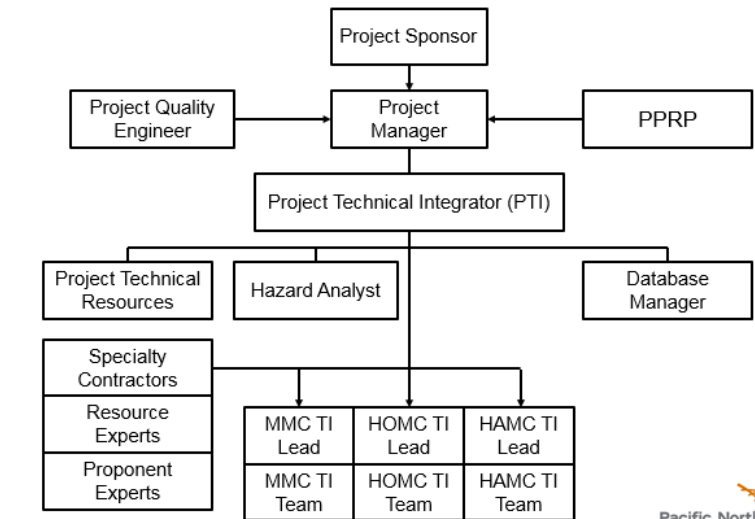
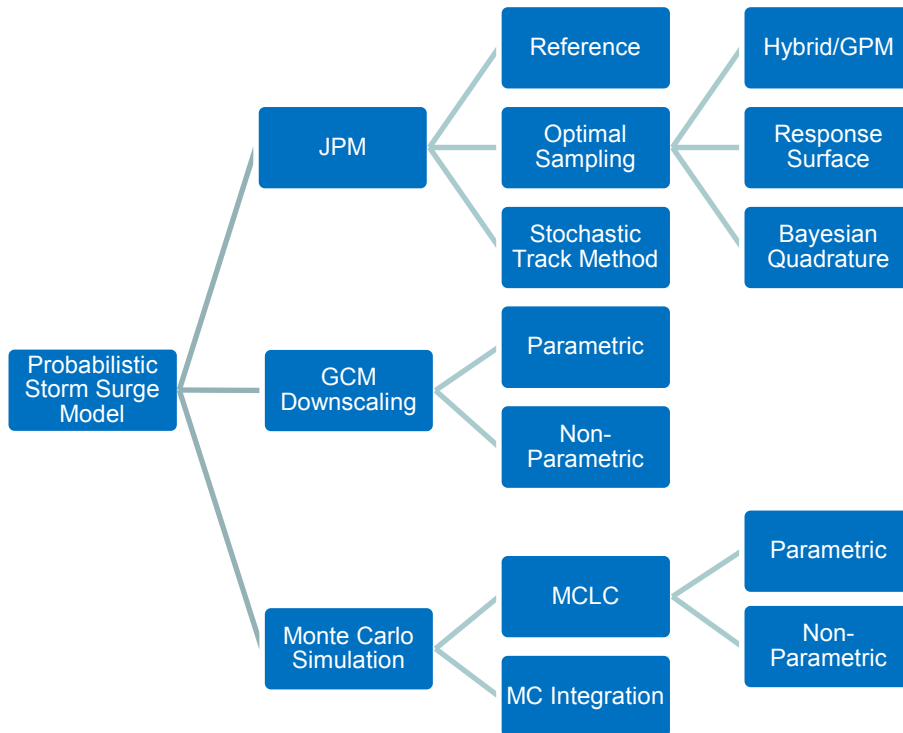
Projected FY19-20 Work*

*** Subject to availability of funding**

Probabilistic Treatment of Coincident and Correlated Hazards and Their Effects

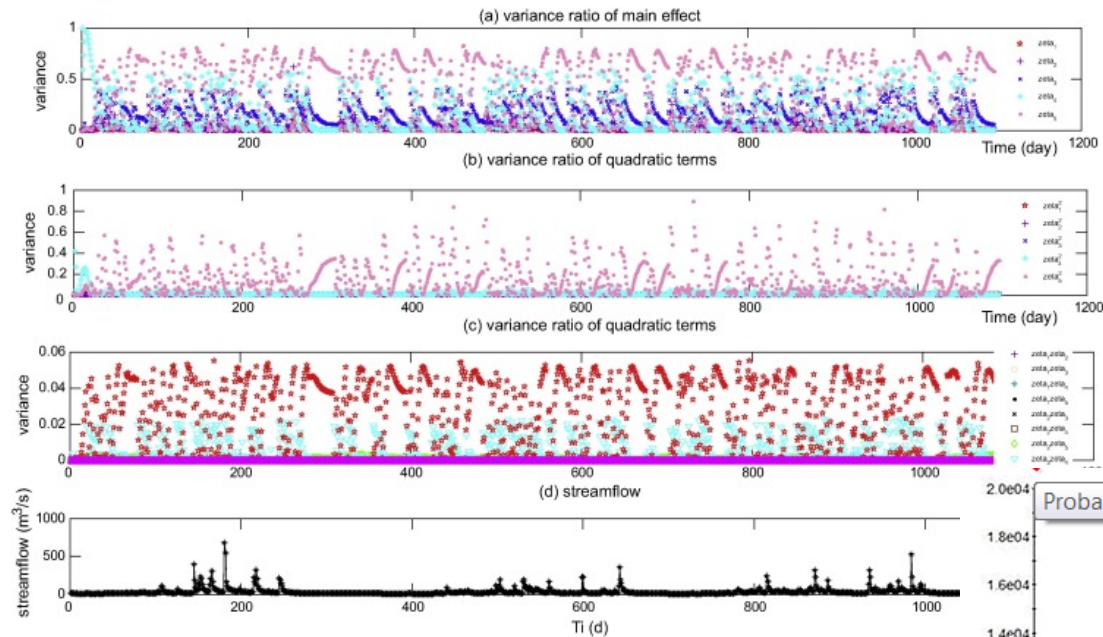


Application of SHAC-F to Coastal Flooding Hazard Assessments

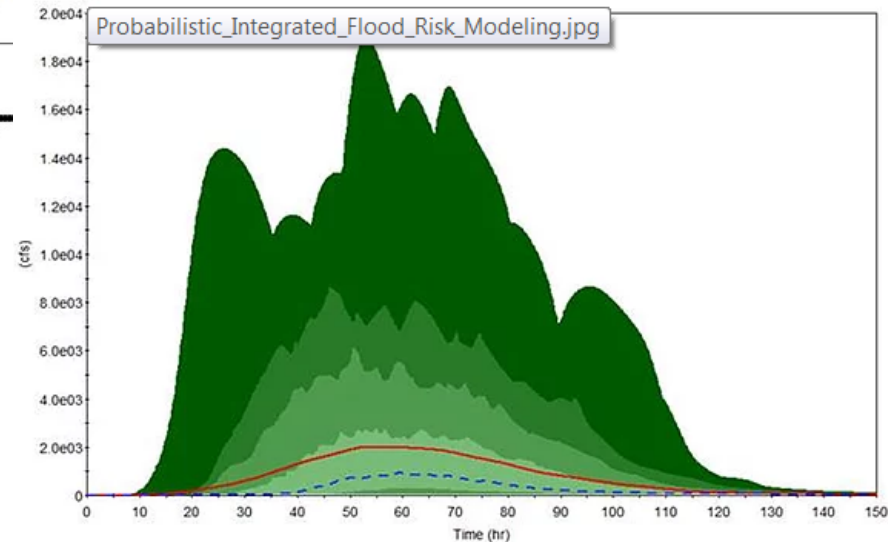


26

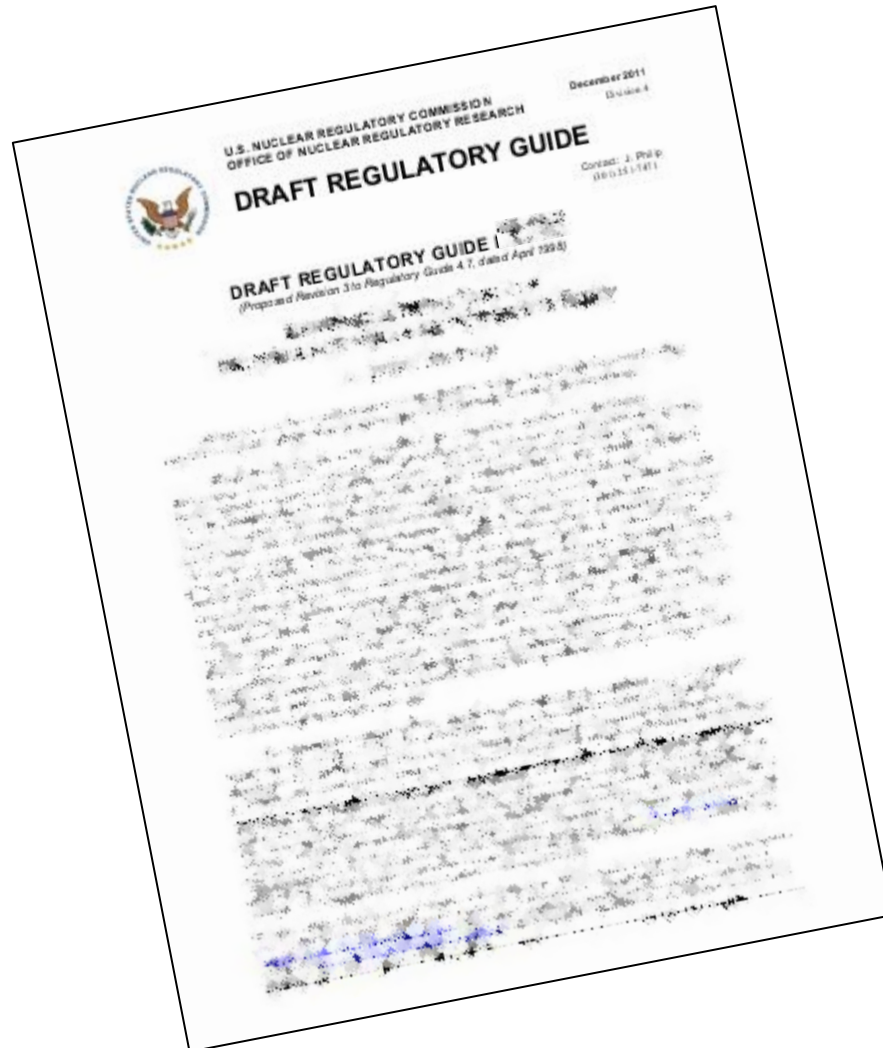
Quantifying Uncertainties in Probabilistic Riverine Flood Models



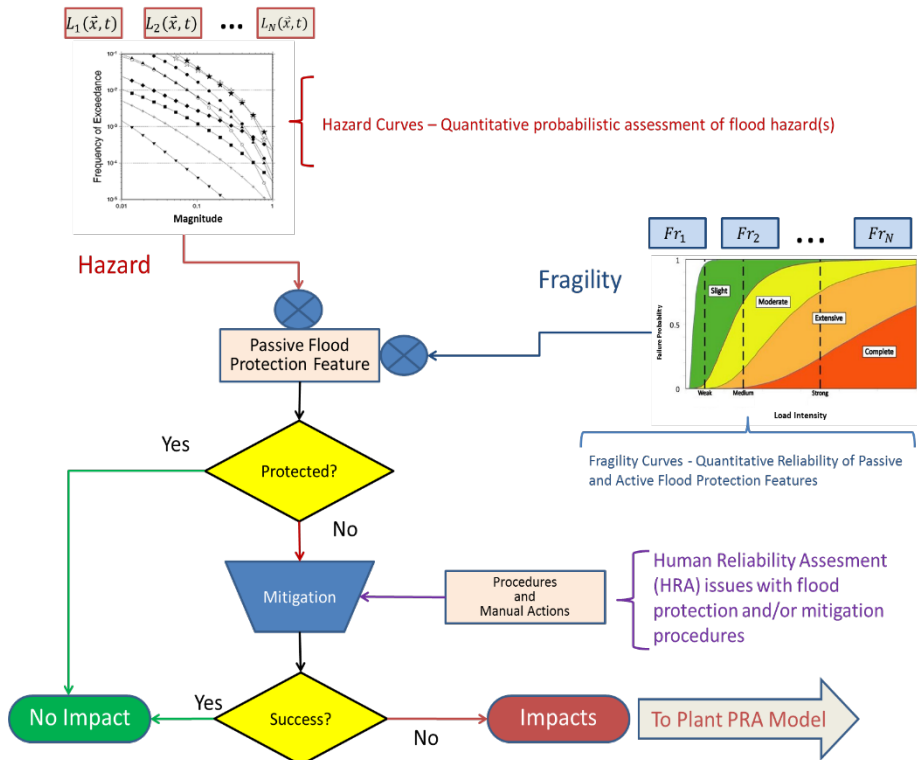
Contributions to model parameters to uncertainty in model predictions: Fan et al, 2015



Draft Regulatory Guidance



Pilot Studies



Initiating Events	Awareness of snow removal necessity	Roof door openable for access route	Access route available by snow removal	EDG available by snow removal	ACS-AC available by snow removal	Manual operation of ACS-AC dampers	MCS-AC available by snow removal	State	Remarks
	1st2nd3rd		1.0m	1.5m	1.5m		1.0m		

