

4th Annual Probabilistic Flood Hazard Assessment Workshop

April 30 - May 2, 2019
 U.S. NRC Headquarters, Rockville, Maryland

On April 30 - May 2, 2019, the Nuclear Regulatory Commission’s Office of Nuclear Regulatory Research (NRC/RES) will host the 4th Annual NRC Probabilistic Flood Hazard Assessment (PFHA) Research Workshop at NRC headquarters in Rockville, Maryland. Staff and contractors from NRC, Electric Power Research Institute (EPRI), federal agencies, industry, and other organizations involved in flood hazard assessment, flood risk assessment, and flood protection/mitigation research will provide information on recent results, current activities, and perspectives on future research directions. This three-day workshop is open to the public at no charge, but registration is required.

AGENDA: TUESDAY, APRIL 30, 2019

09:00 – 09:10 Welcome & Logistics

Session 1A: Introduction

Session Chair: *Meredith Carr, NRC/RES*

09:10 – 09:25	Introduction <i>Raymond Furstenau*</i> , Director, Office of Nuclear Regulatory Research	1A-1
09:25 – 09:45	NRC Flooding Research Program Overview <i>Joseph Kanney*</i> , <i>Meredith Carr</i> , <i>Tom Aird</i> , <i>Elena Yegorova</i> , <i>Mark Fuhrmann</i> and <i>Jacob Philip</i> , NRC/RES	1A-2
09:45 – 10:05	EPRI External Flooding Research Program Overview <i>Marko Randelovic*</i> , Electric Power Research Institute (EPRI)	1A-3
10:05 – 10:20	Nuclear Energy Agency: Committee on the Safety of Nuclear Installations (CSNI): Working Group on External Events (WGEV) Flooding Overview <i>John Nakoski*</i> , NRC/RES	1A-4
10:20 – 10:35	BREAK	

* denotes presenter, ^ denotes remote presenter

Session 1B: Coastal Flooding

Session Chair: *Joseph Kanney, NRC/RES*

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| 10:35 – 11:05 | KEYNOTE: NWS Storm Surge Ensemble Guidance
<i>Arthur Taylor*</i> , National Weather Service / Office of Science and Technology Integration / Meteorological Development Laboratory | 1B-1 |
| 11:05 – 11:30 | Advancements in Probabilistic Storm Surge Models and Uncertainty Quantification Using Gaussian Process Metamodeling
<i>Norberto C. Nadal-Caraballo*</i> , Victor M. Gonzalez, Alexandros Taflanidis, U.S. Army Corps of Engineers (USACE) R&D Center, Coastal and Hydraulics Laboratory | 1B-2 |
| 11:30 – 11:55 | Probabilistic Flood Hazard Assessment Using the Joint Probability Method for Hurricane Storm Surge
<i>Michael Salisbury^</i> , Atkins North America, Inc., Marko Randelovic*, EPRI | 1B-3 |
| 11:55 – 12:20 | Assessment of Epistemic Uncertainty for Probabilistic Storm Surge Hazard Assessment using a Logic Tree Approach
<i>Bin Wang*</i> , Daniel C. Stapleton, David M. Leone, GZA GeoEnvironmental, Inc. | 1B-4 |
| 12:20 – 13:00 | Coastal Flooding Panel
<i>Arthur Taylor, National Weather Service</i>
<i>Victor Gonzalez, USACE Coastal and Hydraulics Laboratory</i>
<i>Michael Salisbury, Atkins North America, Inc.</i>
<i>Bin Wang, GZA GeoEnvironmental, Inc.</i>
Guest Panelist: <i>Chris Bender, Taylor Engineering</i> | 1B-5 |
| 13:00 – 14:00 | LUNCH | |

Session 1C: Precipitation

Session Chair: *Elena Yegorova, NRC/RES*

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|---------------|---|------|
| 14:00 – 14:30 | KEYNOTE: Satellite Precipitation Estimates, GPM, and Extremes
<i>George J. Huffman*</i> , NASA/GSFC | 1C-1 |
| 14:30 – 14:55 | Hurricane Harvey Highlights: Need to Assess the Adequacy of Probable Maximum Precipitation Estimation Methods
<i>Shih-Chieh Kao, Scott T. DeNeale, David B. Watson, ORNL</i>

<i>This presentation was based on – Kao, S.-C., S. T. DeNeale, and D. B. Watson (2019), Hurricane Harvey Highlights: Need to Assess the Adequacy of Probable Maximum Precipitation Estimation Methods, J. Hydrol. Eng., 24(4), 05019005, doi:10.1061/(ASCE)HE.1943-5584.0001768. Further details can be referred to Kao et al. (2019).</i> | 1C-2 |

14:55 – 15:20 Reanalysis Datasets in Hydrologic Hazards Analysis 1C-3
Jason Caldwell, USACE, Galveston District. Presented by John England, USACE, RMC

15:20 – 15:35 **BREAK**

Session 1C: Precipitation, continued...
Session Chair: *Elena Yegorova, NRC/RES*

15:35 – 16:00 Current Capabilities for Developing Watershed Precipitation-
Frequency Relationships and Storm-Related Inputs for Stochastic
Flood Modeling for Use in Risk-Informed Decision-Making 1C-4
M.G. Schaefer, MGS Engineering Consultants, Inc.*

16:00 – 16:25 Factors Affecting the Development of Precipitation Areal Reduction
Factors 1C-5
Shih-Chieh Kao, Scott DeNeale, ORNL*

16:25 – 17:05 Precipitation Panel Discussion 1C-6
George J. Huffman, NASA/GSFC
Shih-Chieh Kao, ORNL
John England, USACE, Risk Management Center
Mel Schaefer, MGS Engineering Consultants
Guest Panelist: Kevin Quinlan, NRC/NRO

17:05 – 17:20 **Daily Wrap-up**

AGENDA: WEDNESDAY, MAY 1, 2019

08:20 – 08:30 Day 2 Welcome

Session 2A: Riverine Flooding

Session Chairs: *Meredith Carr and Mark Fuhrmann, NRC/RES*

08:30 – 9:00 KEYNOTE: Watershed level Risk Analysis with HEC-WAT 2A-1
Will Lehmann, Lea Adams, Chris Dunn, USACE, Institute for Water Resources, Hydrologic Engineering Center (HEC)*

09:00 – 09:25 Global Sensitivity Analyses Applied to Riverine Flood Modeling 2A-2
Claire-Marie Duluc, Vincent Rebour, Vito Bacchi, Lucie Pheulpin & Nathalie Bertrand, Institut de radioprotection et de sûreté nucléaire (IRSN) Radioprotection and Nuclear Safety Institute*

09:25 – 09:50 Detection and attribution of flood change across the United States 2A-3
Stacey A. Archfield, Water Mission Area, U.S. Geological Survey – **Presentation Cancelled***

09:50 – 10:15 Bulletin 17C Flood Frequency and Extrapolations for Dams and 2A-4
Nuclear Facilities
John F. England, USACE, Risk Management Center; Haden Smith, USACE, Risk Management Center; Brian Skahill, USACE R&D Center, Coastal and Hydraulics Laboratory*

10:15 – 10:35 **BREAK**

Session 2A: Riverine Flooding, continued..

Session Chairs: *Meredith Carr and Mark Fuhrmann, NRC/RES*

10:35 – 11:00 Riverine Paleoflood Analyses in Risk-Informed Decision Making: 2A-5
Improving Hydrologic Loading Input for USACE Dam Safety Evaluations
Keith Kelson, USACE, Sacramento Dam Safety Production Center; Justin Pearce, USACE, Risk Management Center; Brian Hall, USACE, Dam Safety Modification Mandatory Center of Expertise*

11:00 – 11:25 Improving Flood Frequency Analysis with a Multi-Millennial Record of 2A-6
Extreme Floods on the Tennessee River near Chattanooga, TN
Tess Harden, Jim O'Connor and Mackenzie Keith, U.S. Geological Survey*

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11:25 – 12:05 Riverine Flooding Panel Discussion
Will Lehmann, USACE/IWR Hydrologic Engineering Center
Claire-Marie DuLuc, IRSN
John F. England, USACE, Risk Management Center
Keith Kelson, USACE, Sacramento Dam Safety Production Center
Tess Harden, U.S. Geological Survey

12:05 – 13:25 **LUNCH**

Session 2B: Modeling Frameworks

Session Chair: *Thomas Nicholson, NRC/RES*

13:25 – 13:50 Structured Hazard Assessment Committee Process for Flooding 2B-1
 (SHAC-F)
*Rajiv Prasad[^] and Phillip Meyer, Pacific Northwest National
 Laboratory; Kevin Coppersmith, Coppersmith Consulting*

13:50– 14:15 Overview of the TVA PFHA Calculation System 2B-2
Shaun Carney, RTI International, Water Resource
 Management Division, Curt Jawdy, Tennessee Valley Authority*

14:15 – 14:40 Development of Risk-Informed safety margin characterization 2B-3
 framework for flooding of nuclear power plants
*M.A. Andre, George Washington University; E. Ryan, Idaho
 State University, Idaho National Laboratory; Steven Prescott,
 Idaho National Laboratory; N. Montanari, R. Sampath, Centroc
 Lab; L. Lin, A. Gupta, N. Dinh, North Carolina State University;
 Philippe M. Bardet*, George Washington University*

14:40 – 15:20 Modeling Frameworks Panel Discussion 2B-4
Rajiv Prasad, Pacific Northwest National Laboratory
Shaun Carney, RTI International
Philippe M. Bardet, George Washington University
Will Lehmann, USACE/IWR, Hydrologic Engineering Center (HEC)
Guest Panelist: Joseph Kanney, NRC/RES

15:20 – 15:35 Daily Wrap-up

15:35 – 16:50

Session 2C: Poster Session

Session Chair: *Meredith Carr, NRC/RES*

2C-1 Coastal Storm Surge Assessment using Surrogate Modeling Methods

Azin Al Kajbaf, Michelle Bensi, Department of Civil and Environmental Engineering, University of Maryland.

2C-2 Methods for Estimating Joint Probabilities of Coincident and Correlated Flooding Mechanisms for Nuclear Power Plant Flood Hazard Assessments

Michelle (Shelby) Bensi, Somayeh Mohammadi; Center for Disaster Resilience, University of Maryland, Scott DeNeale, Shih-Chieh Kao; Environmental Sciences Division, Oak Ridge National Laboratory.

2C-3 Modelling dependence and coincidence of flooding phenomena: methodology and simplified case study in Le Havre in France

A. Ben Daoued, Sorbonne university – Université de Technologie de Compiègne; Y. Hamdi, Institut de Radioprotection et de Sûreté Nucléaire; N. Mouhous-Voyneau, Sorbonne university – Université de Technologie de Compiègne; P. Sergent, Cerema

2C-4 Current State-of-Practice in Dam Risk Assessment

Scott DeNeale; Environmental Sciences Division, Oak Ridge National Lab, Greg Baecher; Center for Disaster Resilience, University of Maryland, Kevin Stewart; Environmental Sciences Division, Oak Ridge National Lab.

2C-5 Hurricane Harvey Highlights the Challenge of Estimating Probable Maximum Precipitation

Shih-Chieh Kao, Scott T. DeNeale, David B. Watson; Environmental Sciences Division, Oak Ridge National Laboratory

2C-6 Uncertainty and sensitivity analysis for hydraulic models with dependent inputs

Lucie Pheulpin, Vito Bacchi and Nathalie Bertrand; Institut de Radioprotection et de Sûreté Nucléaire, Fontenay-aux-Roses, France

2C-7 Development of Hydrologic Hazard Curves using SEFM for Assessing Hydrologic Risks at Rhinedollar Dam, CA

Bruce Barker, MGS Engineering Consultants, Inc., Nicole Novembre, Brava Engineering, Inc., Matthew Muto and John Dong, Southern California Edison, Blake Allen and Katie Ward, MetStat, Inc., Jason Caldwell, Weather & Water, Inc.

2C-8 Probabilistic Flood Hazard Analysis of Nuclear Power Plant in Korea

Kim, Beomjin, Ph.D. Candidate, Kyungpook National University, Korea; Han, Kun-Yeun, Professor, Department of Civil Engineering; Kyungpook National University; Kim, Minkyu, Principal Researcher, Korea Atomic Energy Institute, Korea.

18:00

Group Dinner

AGENDA: THURSDAY, MAY 2, 2019

08:20 – 08:30 Day 3 Welcome

Session 3A: Climate and Non-stationarity

Session Chair: *Joseph Kanney, NRC/RES*

08:30 – 09:00 KEYNOTE: Hydroclimatic Extremes Trends and Projections: A View from the Fourth National Climate Assessment 3A-1
Kenneth Kunkel, North Carolina State University*

09:00 – 09:25 Regional Climate Change Projections: Potential Impacts to Nuclear Facilities 3A-2
L. Ruby Leung and Rajiv Prasad, Pacific Northwest National Laboratory*

09:25 – 09:50 Role of Climate Change/Variability in the 2017 Atlantic Hurricane Season 3A-3
Young-Kwon Lim^{,1,2}, Siegfried Schubert^{1,3}, Robin Kovach^{1,3}, Andrea Molod¹, Steven Pawson¹; ¹NASA Goddard Space Flight Center, Global Modeling and Assimilation Office, ²Goddard Earth Sciences, Technology, and Research / I. M. Systems Group, ³Science Systems and Applications, Inc.*

9:50 – 10:30 Climate Panel Discussion 3A-4
*Kenneth Kunkel, North Carolina State University
L. Ruby Leung, Pacific Northwest National Laboratory
Young-Kwon Lim, GSFC/NASA
Guest Panelist: Kevin Quinlan, NRC/NRO*

10:30 – 10:50 **BREAK**

Session 3B: Flood Protection and Plant Response

Session Chair: *Thomas Aird, NRC/RES*

10:50 – 11:15 External Flood Seal Risk-Ranking Process 3B-1
Ray Schneider, Westinghouse, Marko Randelovic*, EPRI*

11:15– 11:40 Results of Performance of Flood-Rated Penetration Seals Tests 3B-2
William (Mark) Cummings, Fisher Engineering, Inc.

11:40– 1205 Modeling Overtopping Erosion Tests of Zoned Rockfill Embankments 3B-3
Tony Wahl[^], U.S. Bureau of Reclamation

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12:05– 12:45 Flood Protection and Plant Response Panel Discussion 3B-4
Ray Schneider, Westinghouse
William (Mark) Cummings, Fisher Engineering, Inc.
Tony Wahl[^], U.S. Bureau of Reclamation
Guest Panelist: Jacob Philip, NRC/RES

12:45 – 13:45 **LUNCH**

Session 3C: Towards External Flooding PRA

Session Chair: *Joseph Kanney, NRC/RES*

13:45 – 14:10 External Flooding PRA Walkdown Guidance 3C-1
Andrew Miller, Jensen Hughes, Marko Randelovic*, EPRI*

14:10 – 14:35 Updates on the Revision and Expansion of the External Flooding PRA Standard 3C-2
Michelle (Shelby) Bensi, University of Maryland*

14:35 – 15:00 Update on ANS 2.8: Probabilistic Evaluation of External Flood Hazards for Nuclear Facilities Working Group Status 3C-3
Ray Schneider, Westinghouse

15:00 – 15:25 Qualitative PRA Insights from Operational Events of External Floods and Other Storm-Related Hazards 3C-4
Nathan Siu, Ian Gifford, Zeechung (Gary) Wang, Meredith Carr and Joseph Kanney, NRC/RES*

15:25 – 16:05 Towards External Flooding PRA Discussion Panel 3C-5
Andrew Miller, Jensen Hughes
Michelle (Shelby) Bensi, University of Maryland
Ray Schneider, Westinghouse
Ian Gifford, NRC/RES
Guest Panelist: Suzanne Denis, NRC/RES
Guest Panelist: Jeremy Gaudron, EDF

16:05 – 16:25 Wrap-up Discussion