AGU-IUGG Centennial Symposium on Disaster Science: Risk Reduction, Resilience, Response, and Recovery

December 9, 2018

Venue: Grand Hyatt, Independence A-E, 1000 H Street NW, Washington, DC

The International Union of Geodesy and Geophysics (IUGG) and the American Geophysical Union (AGU), hereafter known as AGU-IUGG, will celebrate in 2018/2019 the centennial of their founding in 1919. AGU and IUGG seek to foster a dialogue on the growth of science and its impacts over the past 100 years, especially in the area of disaster science. To that effect, AGU-IUGG, in partnership with the U.S. National Committee for the International Union of Geodesy and Geophysics (USNC/IUGG) of the National Academies of Sciences, Engineering, and Medicine, agreed to organize a series of two Centennial Disaster Science meetings. The first is a symposium on 9 December 2018 in Washington, D.C., USA, to be held in conjunction with the 2018 AGU Fall Meeting (10-14 December 2018). A follow-on symposium "Georisk Reduction: Science, Resources, and Governmental Action" will be held on 14 July 2019 in Montréal, Canada, in conjunction with the 27th IUGG General Assembly (8-18 July 2019). These two meetings will focus on improving the role of science in disaster risk reduction, resilience, response, and recovery. AGU and IUGG expect that these meetings will identify mechanisms for improved coordination between scientists, engineers, decision-makers, disaster managers, and funding agencies. A white paper will report on the outcome of the meetings.

The AGU-IUGG Centennial Symposium on Disaster Science will apply the knowledge and experience gained from specific natural disasters to improve the impact of scientific research in disaster policy, response, and recovery. The symposium will adopt the Sendai Framework for Disaster Risk Reduction as the guiding document. The symposium will concentrate on the four priorities of the Sendai Framework: (i) Understanding disaster risk; (ii) Strengthening disaster risk governance to manage disaster risk; (iii) Investing in disaster risk reduction for resilience, and (iv) "Build Back Better" in recovery, rehabilitation, and reconstruction. The symposium seeks to identify, understand, and improve the role of disaster science in each of these four priorities. Some areas of discussion might include:

- What scientific advances do we need to more effectively prepare for and respond to disasters?
- How can we better use current science to reduce risk and enhance resiliency?
- How can we mitigate the impacts of hazards and reduce the cost of recovering from disasters?
- How can we make society more resilient to disasters?
- How do we ensure proper allocation of resources to build back better or build elsewhere in a weak or strong economy?

The symposium format will consist of one keynote presentation and four panel discussions. Each panel is followed by a 30-minute period to encourage discussion amongst the panel members and the audience. The final session will be an open period of dialogue on recommendations to be included in a symposium's report as well as in the white paper. We seek strong audience participation in each of these panel discussions and open audience discussion periods.

PROGRAM

8:00 AM – 8:30 AM

Welcome and Symposium Charge

- ***John LaBrecque***, Symposium Moderator; Chair, IUGG Commission on Geophysical Risk and Sustainability
- ***Eric Davidson***, President, AGU
- ***Michael Sideris***, President, IUGG

8:30 AM – 9:30 AM

Keynote presentation on Symposium Goals and Disaster Preparedness – opportunities and obstacles in science, policy, and finance

- ***Marcia McNutt***, President, National Academy of Sciences (NAS)

9:30 AM - 10:15 AM

Panel 1: Science in Disaster Risk Appraisal and Management

Scope

Disasters are the likely outcome of human activity in the presence of a natural hazard. An approach to minimize the risk of disaster is to accurately appraise the risk and manage the human activity and its environment. Such disaster management varies greatly within the international community and includes both emerging and developed economies. The first priority of the Sendai Framework for Disaster Risk Reduction 2015-2030 is to address hazard appraisal, vulnerability, and exposure. Can we improve the contribution of the latest scientific and technological findings to disaster risk assessment, particularly for complex or cascading disasters?

Discussion Moderators

- ***Alik Ismail-Zadeh***, Karlsruhe Institute of Technology, Karlsruhe, Germany | Russian Academy of Sciences, Moscow, Russia | IUGG

- ***Ester Sztein***, NAS, Washington, D.C.

Panelists

- ***David Applegate***, U.S. Geological Survey (USGS), Reston, VA
- ***Susan Cutter***, University of South Carolina, Columbia, SC
- ***Carlo Doglioni***, Istituto Nazionale di Geofisica e Vulcanologia (INGV), Rome, Italy
- ***Laura Kong***, UNESCO Intergovernmental Oceanographic Commission (IOC) International Tsunami Information Center, Honolulu, HI

Discussion Topics

- Are S&T applied to disaster risk mitigation and management with sufficient ease and in a timely manner? What should be done to fill the gap between the knowledge of risks and actual risk management?
- Do we have sufficient understanding of the probabilities of natural hazard events occurring with specific intensities? And if so, how can policymakers be persuaded to invest in actions that will reduce the impact of and increase resilience to extreme natural hazard events?
- How should science contribute to assessments of disaster risks to help policymakers in developing relevant policies at each stage of disaster management?
- What is the role of science communication and how well is it developed? What is still missing in communications between scientists and policymakers, end-users, engineers, representatives of industry and media?
- How should we move from disciplinary-based to co-designed and co-productive trans-disciplinary work of different stakeholders including scientists? Who will finance the transdisciplinary work of scientists?

10:15 AM - 10:45 AM

Panel 1: Audience Discussion

10:45 AM - 11:00 AM

Break

11:00 AM - 11:45 AM

Panel 2: Science for Risk Reduction, Resilience and Response to Disasters

Scope

Can we improve the transition of findings from research to their implementation for risk reduction, increased societal resilience and improved response to natural disasters? The panel will focus on the benefits of scientific and technological research with examples of developing or implementing existing science and technology. The panel will discuss approaches to improve the transition from advances in scientific research to the operational implementation of these scientific advances.

Discussion Moderators

- ***Yekaterina (Katia) Kontar***, Tufts University, Medford, MA
- ***Leah Salditch***, Northwestern University, Evanston, IL
- ***Seth Stein***, Northwestern University, Evanston, IL

Panelists

- ***Timothy Dixon***, University of South Florida, Tampa, FL
- ***Ken Hudnut***, USGS, Pasadena, CA
- ***John N. Ludden***, British Geological Survey, Keyworth, UK
- ***Diego Melgar***, University of Oregon, Eugene, OR

Discussion Topics

- How well do we understand the probabilities of significant natural disasters? Are we confident that we understand the likelihood and impact of significant events?
- What do you consider our major scientific contributions to hazard mitigation and resilience? What do you consider our major failures? How can we do better?
- Are we effectively communicating disaster-related science to policymakers, media, the public, and other scientists?
- What scientific advances do we need to improve risk reduction, resilience, and response to disasters?

11:45 AM- 12:15 PM

Panel 2: Audience Discussion

12:15 PM - 1:00 PM

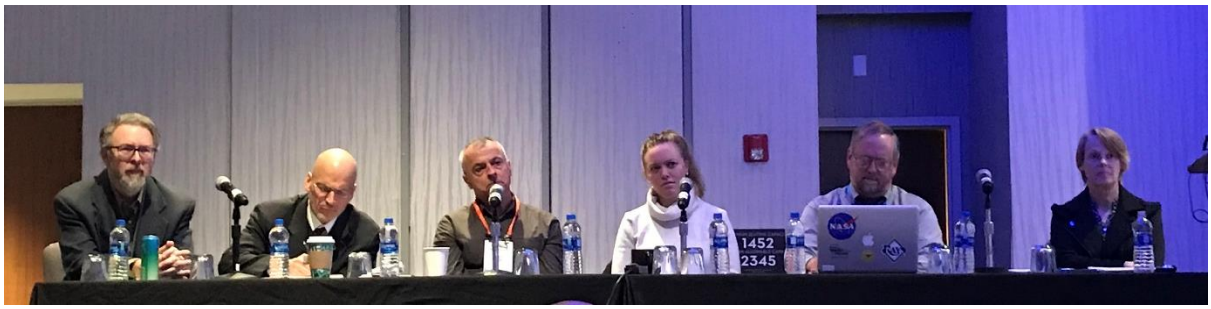
Lunch

1:00 PM - 1:45 PM

Panel 3: Dealing with Cascading Hazards That May Lead to a Regional or Global Disaster

Scope

A natural hazard can sometimes cascade into a disaster that involves one hazard leading to another, such as an earthquake causing a tsunami. A natural hazard can also lead to a built environment disaster, such as the damage from the destruction of the Fukushima nuclear power plant following the Tohoku earthquake and tsunami. While the geosciences may be focused on understanding Earth processes, science needs to consider a hazard leading to multiple hazards that cause a disaster of local or even global proportions. Geoscientists need to work with engineers, policymakers, the insurance industry, and emergency responders to explain the Earth processes that may lead to one or more hazards, including some consideration of the built environment and where infrastructure/communities may be most affected by a hazard. The panel will discuss how science can inform policy, insurance, preparedness and emergency response to deal with cascading hazards before they become disasters.



Discussion Moderators

- ***Stephen McNutt***, University of South Florida, Tampa, FL
- ***Linda Rowan***, UNAVCO, Boulder, CO

Panelists

- ***Fernando Echavarria***, U.S. Department of State's Bureau of Oceans, Environment, and Science
- ***Annie Hoefler***, U.S. Senate Energy and Natural Resources Committee
- ***Harold Magistrale***, FM Global, Norwood, MA
- ***Jay Wilson***, Department of Disaster Management, Clackamas County, OR

Discussion Topics

- How do policymakers, insurers, and emergency managers try to deal with the concerns about cascading hazards that might lead to a regional or global disaster?
- How can geoscientists help with policies, insurance, and emergency management to reduce risks and improve resiliency to one or more hazards?
- A hazard may start locally, but through cascading hazards lead to a more global risk that requires international cooperation. How can risk reduction and resilience from one or more hazards be enhanced from the local to global community?

1:45 PM - 2:15 PM

Panel 3: Audience Discussion

2:15 PM – 2:30 PM

Break

2:30 PM - 3:15 PM

Panel 4: Understanding the Societal Impact of Severe Weather

Scope

Science and technology have developed powerful new tools to measure, identify, and forecast disaster risk. Weather forecast now provides several days of advanced warning. Climate models provide consistent forecasts of environmental change at decadal periods. Space-based observations can provide a few hours of warning in advance of severe space weather. Are these extraordinary capabilities being applied effectively in disaster risk analysis and in support of effective disaster management? Is the profile of scientific analysis providing an effective public voice on mitigation of extreme environmental events (such as storms, floods, heat, cold, drought, wildfires, and space weather) and climatic variability?

Discussion Moderators

- ***Rick Murnane***, Kinetic Analysis Corporation, Silver Spring, MD
- ***Alan Thomson***, British Geological Survey, Edinburgh, UK

Panelists

- **Efi Foufoula-Georgiou,** University of California, Irvine, CA
- ***Stéphane Hallegatte***, Global Facility for Disaster Reduction and Recovery (GFDRR), World Bank
- ***Alice Hill***, Hoover Institution at Stanford University, Stanford, CA
- ***Bill Murtagh***, National Oceanic and Atmospheric Administration (NOAA)

Discussion Topics

- What are the most important factors from past events that we still need to address for future events?
- In contrast, what are the gaps in our knowledge that limit our ability to understand the range and consequences of severe weather and climate change?
- Interdisciplinary - are there places or activities where efforts can be combined to greater effect in anticipating extremes and moderating impacts?
- What are the consequences of climatic changes and the relationship of climate change to severe weather?

3:15 PM - 3:45 PM

Panel 4: Audience Discussion

3:45 PM – 4:00 PM

Break

4:00 PM - 5:00 PM

Conclusions and Recommendations

Scope

Audience and panelists discuss key elements to be included in a white paper to be prepared following the Symposium “Georisk Reduction: Science, Resources, and Governmental Action”, 14 July 2019 in Montréal, Canada. Key topics should include approaches to:

1. Mitigate disasters and reduce cost expenditures related to natural disasters
2. Increase societal preparedness to natural disasters
3. Effectively prepare for and respond to natural disasters through scientific research
4. Better use of current science to reduce risk and enhance resilience
5. Ensure proper allocation of resources to build back better or build elsewhere in a weak and strong economy

Moderator

John LaBrecque

Report on four Panel sessions by Moderators (5 minutes each) followed by audience response and discussion.

5:00 PM

Closing statements

BIOGRAPHIC SKETCHES

Eric Davidson is Director and Professor at the Appalachian Laboratory of the University of Maryland Center for Environmental Science in Frostburg, a position he has held since 2015. Previously, he held postdoctoral positions at the University of California, Berkeley and the NASA Ames Research Center, and was a senior scientist and served a term as president and executive director at the Woods Hole Research Center in Woods Hole, Mass. His research in biogeochemistry includes the exchange of plant nutrients from the land to streams and groundwater and the exchange of greenhouse gases between the soil and the atmosphere. He is an internationally recognized expert in human alteration of the global nitrogen cycle and the temperature sensitivity of soil microbial processes. Dr. Davidson is an AAAS Fellow and is the current President of AGU (2017-2018).

John LaBrecque is Chair of the IUGG Commission on Geophysical Risk and Sustainability and Lead of the Geohazards Monitoring Focus Area of the Global Geodetic Observing System, a program of the International Association of Geodesy (IAG) of IUGG. Dr. LaBrecque is a research fellow of the Center for Space Research at the University of Texas, Austin. Dr. LaBrecque is currently focused upon the application of geodetic science and technology for the mitigation of natural hazards and disaster response, in particular in the application of real time Global Navigation Satellite System technology to tsunami and earthquake early warning through the development of international collaboration. Dr. LaBrecque led NASA's Solid Earth Science programs for nearly twenty years including NASA's geodetic infrastructure and research programs, and its satellite gravity, geomagnetics and topography research missions.

Michael Sideris is Professor in the Department of Geomatics Engineering, University of Calgary, Canada. He has worked at the university since 1987 and was the Department's Associate Head for Graduate Studies and its Associate Dean. His expertise is in the fields of satellite Earth observation including gravity field approximation, geoid modeling, satellite missions, and their Earth-monitoring applications. Dr. Sideris has also been an advisor/consultant to a number of geophysical and engineering companies and to the Australian, Canadian and US National Geodetic Surveys, as well as member of the Board of Directors of several scientific and engineering institutes/organizations. He was Vice President and President of the International Association of Geodesy (IAG) of IUGG, and IUGG Vice President before he was elected IUGG President (2015-2019). Dr. Sideris serves on the Program Board of the Group on Earth Observations (GEO) representing IUGG.

Keynote Speaker

Marcia McNutt is a geophysicist and President of the National Academy of Sciences. She was the E.A. Griswold Professor of Geophysics at Massachusetts Institute of Technology (MIT) and directed the Joint Program in Oceanography/Applied Ocean Science & Engineering, jointly offered by MIT and the Woods Hole Oceanographic Institution. Her research area is the dynamics of the upper mantle and lithosphere on geologic time scales. Dr. McNutt served as President and Chief Executive Officer of the Monterey Bay Aquarium Research Institute, in Moss Landing, CA. Dr. McNutt was Director of the U.S. Geological Survey (USGS) from 2009 to 2013. During her tenure, the USGS responded to a number of major disasters, including earthquakes in Haiti, Chile, and Japan, and the Deepwater Horizon oil spill. Dr. McNutt led a team of government scientists and engineers at BP headquarters in Houston who helped contain the oil and cap the well. From 2013 to 2016, she served as editor-in-chief of the *Science* family of journals. Her honors include AGU's Macelwane and Maurice Ewing Medals, and she is a Fellow of AGU, Geological Society of America, AAAS, and IAG of IUGG. She is Foreign Member of Academia Europaea, the Royal Society, and the Russian Academy of Sciences. Dr. McNutt served as AGU President from 2000 to 2002.

PANEL 1

Moderators

Alik Ismail-Zadeh is Senior Research Fellow at Karlsruhe Institute of Technology, Germany, and Chief Scientist and Head of Research Group "Computational Geodynamics and Geohazards Modeling" at the Russian Academy of Sciences Institute, Moscow, Russia. Dr. Ismail-Zadeh is IUGG Secretary-General (2007-2019) and Secretary General of the International Science Council (2018-2021). He is the Founding President of the AGU Natural Hazards Section and Founding Vice-Chair of the IUGG Commission on Geophysical Risk and Sustainability. He has served in several committees of intergovernmental organizations related to natural hazards and disaster risks, including UNESCO and the U.N. Global Platform for Disaster Risk Reduction.

Ester Sztein is Assistant Director of the Board on International Scientific Organizations and Deputy Director of the Board on Research Data and Information of the National Academy of Sciences, Engineering, and Medicine (NASEM). Among other programs, she manages the U.S. National Committees for the International Unions for Quaternary research, geological sciences, geodesy and geophysics, and soil sciences. She has given talks and published on science diplomacy in the geosciences and co-authored a well-regarded review on soils and human security. Dr. Sztein serves in professional societies including the Geological Society of Washington, International Medical Geology Association, and AGU's Technical Committee on Soil Systems and Critical Zone Processes.

Panelists

David Applegate is the Associate Director for Natural Hazards of the U.S. Geological Survey (USGS). Dr. Applegate came to the USGS in 2004 as the first Senior Science Advisor for Earthquake and Geologic Hazards. Since 2006, he has chaired the National Science and Technology Council's Subcommittee on Disaster Reduction, an interagency body providing guidance to the White House Office of Science and Technology Policy. Prior to joining the USGS, Dr. Applegate served as the director of government affairs of the American Geological Institute, and was the Editor of Geotimes. He has also served with the U.S. Senate Committee on Energy and Natural Resources as the AGU's Congressional Science Fellow and as a professional staff member.

Susan L. Cutter is a Carolina Distinguished Professor of Geography at the University of South Carolina, where she directs the Hazards and Vulnerability Research Institute. Her primary research interests are in the area of disaster vulnerability/resilience science. Cutter served as Vice-Chair of the Integrated Research on Disaster Risk (IRDR) Science Committee co-sponsored by the International Science Council and UNISDR. She was a coordinating lead author of the IPCC Special Report on Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation. She chaired the committee that produced the National Research Council report Disaster Resilience: A National Imperative. Cutter held the MunichRe Foundation Chair on Social Vulnerability.

Carlo Doglioni is the president of the Italian National Institute of Geophysics and Volcanology (INGV), the institute of reference for Italian governmental bodies in the field of geohazards, and Full Professor of Geodynamics at the Sapienza University of Rome. Among many topics, he has researched asymmetry of orogens and foreland basins as a function of the subduction polarity, asymmetry of rift zones, evidence for the polarization of plate tectonics, tectonic asymmetry of plate boundaries, and Earth's rotation role in driving plate tectonics. Dr. Doglioni was President of the Italian Geological Society and has been Editor-in-Chief of Earth Science Reviews since 2012.

Laura Kong is the Director of the Intergovernmental Oceanographic Commission (IOC) of UNESCO and NOAA International Tsunami Information Center (ITIC). As Director, she oversees a Centre that supports IOC in its efforts to deploy tsunami warning and mitigation systems globally, and works directly with the 46-nation Intergovernmental Co-ordination Group for the Pacific Tsunami Warning and Mitigation System to strengthen national tsunami warnings and preparedness. Kong has been actively involved as part of the IOC's coordination and development of systems in the Indian Ocean, the Caribbean and adjacent regions, and Mediterranean Seas and the north Atlantic Ocean. Within the United States, Kong serves as the Hawaii State Tsunami Advisor, and is supports the US National Tsunami Hazard Mitigation Program.

PANEL 2

Moderators

Yekaterina (Katia) Kontar is a postdoctoral fellow at the Fletcher School of Law and Diplomacy, Tufts University, and an early-career Member of the IUGG Commission on Geophysical Risk and Sustainability. Her research focuses on knowledge and information systems in the context of environmental, economic, and societal elements associated with disaster resilience in the Arctic. Dr. Kontar joined the Fletcher School from the University of Alaska Fairbanks, where she received her doctoral degree in Science Communication and Policy. A key accomplishment of her research was a facilitation of a dialogue among stakeholders involved in springtime flood management in Alaska, USA, and Yakutia (Siberia), Russia.

Leah Salditch Leah is a PhD Candidate at Northwestern University studying earthquake hazards and statistics under the advisement of Dr. Seth Stein. She is a fellow of the Northwestern Institute for Policy Research and is the student Liaison to the Natural Hazards Focus Group of the AGU. Part of her research looks at large earthquake temporal clusters from a probabilistic perspective. For this work, she received the Seismological Society of America Student Presentation Award in 2017. Her recent publication looks at the qualitative intensity distribution from a large historical earthquake in California, which can facilitate a better understanding of how well current probabilistic seismic hazard assessments perform.

Seth Stein is Deering Professor of Geological Sciences at Northwestern. His research interests are in plate tectonics and earthquake seismology. He was awarded AGU's Macelwane Medal, GSA's Woollard Award, EGU's Mueller Medal, the RAS's Price Medal and a Humboldt Foundation Research Award. He is a foreign member of the Academy of Europe, Fellow of AGU and GSA, and on ISI's Highly Cited Researchers list. He was an organizer of EarthScope and served as Scientific Director of UNAVCO. He is president-elect of AGU's Natural Hazards Section, authored books on natural hazard science and policy and about earthquakes in the central U.S., coauthored a widely used seismology textbook, edited six other books, and edited the JGR.

Panelists

Timothy Dixon is a Professor at the University of South Florida's Department of Geology and School of Geosciences. Distinguished Lecturer for the American Association of Petroleum Geologists (2006-2007), is a Fellow of AGU and GSA, received a GSA "Best Paper" award in 2006, and received GSA's Woollard award in 2010. Dr. Dixon's research utilizes satellite geodesy and remote sensing data (GPS, InSAR) to study Earth surface and sub-surface processes, including earthquakes and volcano deformation, mountain building, coastal subsidence, ground water extraction and glacier motion.

Ken Hudnut is the Science Advisor for Risk Reduction for USGS. He ensures that USGS hazards science is being applied to help solve societally relevant problems. To help understand the San Andreas Fault system and the behavior of faults in general, he has studied earthquakes worldwide using satellite & airborne imagery along with field work to provide ground truth. Dr. Hudnut received AGU's Ivan I. Mueller Award for distinguished service and leadership and the Meritorious Service Award from the U.S. Department of the Interior. He is a Visiting Associate in Geophysics at Caltech and a lecturer on engineering geology in Civil & Environmental Engineering at UCLA.

John N. Ludden is the Executive Director at the British Geological Survey since 2006, Dr. Ludden has held numerous science direction and management posts. He was Director of the Earth Sciences Division at the French National Centre for Scientific Research (CNRS) and also served as Director of Research for the CNRS in Nancy, France, where he also taught at the French National School of Geology (ENSG-Nancy). Prior to this, Dr. Ludden worked at the University of Montréal, Columbia University, and with Woods Hole Oceanographic Institution. Dr. Ludden is a visiting professor at Oxford and Leicester universities and a Foreign Member of the Russian Academy of Sciences. He is a past president of the European Geosciences Union and of EuroGeoSurveys.

Diego Melgar is Assistant Professor of Earth Sciences at the University of Oregon. His research involves the physics of earthquake rupture; computing earthquake magnitudes from high-sample-rate GPS; and developing methodology for a rapid and efficient tsunami warning system for the Pacific Rim. His work has relevance to the ShakeAlert earthquake early warning system for the U.S. west coast and NOAA's Tsunami Warning Centers. He is also in charge of maintaining the Bay Area Regional Deformation Network, a real-time GPS network that monitors crustal deformation for earthquake hazard

reduction studies and earthquake response. He was awarded the SSA's Charles F. Richter Early Career Award.

PANEL 3

Moderators

Stephen McNutt is a volcano seismologist who coordinates volcano seismology research for the Department of Geosciences at the Univerity of South Florida. He worked half time for the Alaska Volcano Observatory from 1991-2012, responding to dozens of volcanic eruptions. Dr. McNutt's research interests include studies of source and propagation effects for volcanic seismic events; volcanic hazards assessments in Alaska, California, and Central America; the mechanical behavior of volcanoes; volcano infrasound; and volcanic lightning. From July 1999 to July 2007 Dr. McNutt served as Secretary-General for the International Association of Volcanology and Chemistry of the Earth's Interior (IAVCEI) of IUGG, and he is the Chair of the U.S. National Committee for IUGG.

Linda Rowan is the Director of External Affairs at UNAVCO, Inc. Previously she was Director of Geoscience Policy at the American Geosciences Institute, where she worked at the intersection of the geosciences and policy at the Federal level and managed internship and fellowship programs. Dr. Rowan taught a course on Earth Science and Policy as an adjunct faculty member of the Atmospheric, Oceanic, and Earth Sciences Department at George Mason University in Fairfax, VA. She worked also as an editor at Science magazine handling research papers and related materials in the Earth and Space sciences. Dr. Rowan is President of the AGU Societal Impacts and Policy Sciences Section and a member of the government affairs committee of the Seismological Society of America.

Panelists

Fernando R. Echavarria works as an advisor on international Earth observation, geospatial and geothermal science and technology issues at the U.S. Department of State's Bureau of Oceans, Environment and Science (OES). He has led several public private partnerships on geospatial science and technology for the U.S. government at large international meetings including: the World Summit on Sustainable Development (Johannesburg, 2002), the World Conference on Disaster Reduction (Kobe, 2005), the World Summit on the Information Society (Tunis, 2005), the World Conference on Sustainable Development (Rio, 2012), the Sixth World Urban Forum (Medellin, 2014). He has held teaching positions at the University of Nebraska-Lincoln, George Washington University and the U.S. Department of State's Foreign Service Institute.

Annie Hoefler is a Professional Staff Member on the Senate Energy and Natural Resources Committee with a focus on Natural Resources and Federal Land Issues. Hoefler served as a legislative aide, executive assistant, staff assistant, and college intern for the committee before being promoted to professional staff member. She will focus primarily on natural resources and federal lands issues. Ms. Hoefler is originally from Anchorage, Alaska and earned her B.A. in geography from Colgate University in 2015.

Harold Magistrale is a Principal Research Scientist and technical team leader for geological sciences research at FM Global, where he is responsible for the worldwide earthquake risk zone maps that guide underwriting and field engineering decisions. Prior to joining FM Global nine years ago, he was an Adjunct Professor at San Diego State University where he researched southern California faults, earthquakes, and crustal structure. Harold has a B.S. in Earth Sciences from U.C. Santa Cruz, a Ph.D. in Geophysics from Caltech, and a J.D. from the University of San Diego School of Law.

Jay Wilson is the Clackamas County Resilience coordinator with the Department of Disaster Management and spearheads County efforts to reduce risks and assess hazards including flood, earthquake, wildfire, volcano, and climate change impacts. He is the past-chair (2014-2017) of the Oregon Seismic Safety Policy Advisory Commission and previously worked for Oregon Emergency Management and as a mitigation reservist with FEMA Regions IX and X. Jay Wilson recently completed a two-year appointment as a resilience fellow with the National Institute of Standards and Technology during the development of the 2015 Community Resilience Planning Guide. He is a member of the Earthquake Engineering Research Institute and has completed post-earthquake reconnaissance trips to Japan (2011) and Central Italy (2017).

PANEL 4

Moderators

Rick Murnane is Senior Vice President and Deputy CEO and Kinetic Analysis Corporation. He is particularly interested in making science understandable and useable. He is on the advisory board of AGU's Thriving Earth Exchange and is the Chair of AGU's Meeting Committee. Rick worked with the Global Facility for Disaster Reduction and Recovery as a Senior Disaster Risk Manager and been involved with several risk modeling companies in addition to being a Senior Scientist at the Bermuda Institute of Ocean Sciences. Rick received a Ph.D. in Geological and Geophysical Sciences from Princeton University where was also on the research staff of the Program in Atmospheric and Oceanic Sciences.

Alan W P Thomson is Head of Geomagnetism research at the British Geological Survey. He is a researcher in global magnetic field modelling and source field interpretation and specializes in the space weather and geomagnetic hazard to technology. Dr. Thomson is Chair of the INTERMAGNET Executive Council and is a member of the SuperMAG steering committee. He is a member of Executive Committee of the International Association of Geomagnetism and Aeronomy (IAGA) of IUGG and is a member of the IUGG GeoRisk Commission. He was a member of the Royal Academy of Engineering commission on space weather hazard to technological systems (2012-2013) and is a current member of the UK government 'Space Environment Impact Expert Group'.

Panelists

Efi Foufoula-Georgiou is a Distinguished Professor in the Department of Civil and Environmental Engineering at the Henry Samueli School of Engineering, University of California, Irvine. From 1989-2016 she was the University of Minnesota's McKnight Distinguished Professor in the Department of Civil, Environmental and Geo-Engineering, the Joseph T. and Rose S. Ling Chair in Environmental Engineering, and a Founding Fellow of the Institute on the Environment. She has served as Director of the NSF Science and Technology Center "National Center for Earth-surface Dynamics" and Director of the St. Anthony Falls Laboratory at the University of Minnesota and a member of the UCAR Board of Trustees. Her area of research is hydrology and geomorphology, with special interest on scaling theories, multiscale dynamics and space-time modeling of precipitation and landforms.

Stéphane Hallegatte is a lead economist with the Global Facility for Disaster Reduction and Recovery (GFDRR) at the World Bank. He joined the World Bank in 2012 after 10 years of academic research in environmental economics and climate science for Météo-France, Centre International de Recherche sur l'Environnement et le Développement (CIRED), and Stanford University. His research interests include the economics of natural disasters and risk management, climate change adaptation, urban policy and economics, climate change mitigation, and green growth. Mr. Hallegatte was a lead author of the 5th Assessment Report of the Intergovernmental Panel on Climate Change (IPCC).

Alice Hill serves as a Research Fellow at Stanford University's Hoover Institution, addressing risks, consequences, and responses associated with catastrophic global events, including the cascading failure of infrastructure and social systems. She has an uncommon blend of experience as a federal prosecutor, judge, special assistant to the president, and senior director for the National Security Council. At the White House, she led the development of policy regarding national security and climate change, building climate resilience considerations and capabilities into international development and other federal initiatives, and developing national risk-management standards for the most damaging natural hazards.

Bill Murtagh currently serves as the Program Coordinator for the NOAA Space Weather Prediction Center (SWPC) in Boulder, Colorado. Murtagh regularly briefs leadership and staff of Congress, Federal agencies, and industry on science, services, and policies related to space weather and works to advance international cooperation in space weather-related activities. In 2016, he completed a 26-month assignment in the White House Office of Science and Technology Policy (OSTP) as the Assistant Director for Space Weather. At OSTP he oversaw the development and implementation of the National Space Weather Strategy and National Space Weather Action Plan (NSWAP). Murtagh joined NOAA in 2003 after 23 years as an US Air Force weather forecaster, where he provided meteorological support and coordination for national security interests later joining SWPC as a space weather forecaster and liaison between NOAA and the U.S. Air Force.