BOOK OF ABSTRACTS

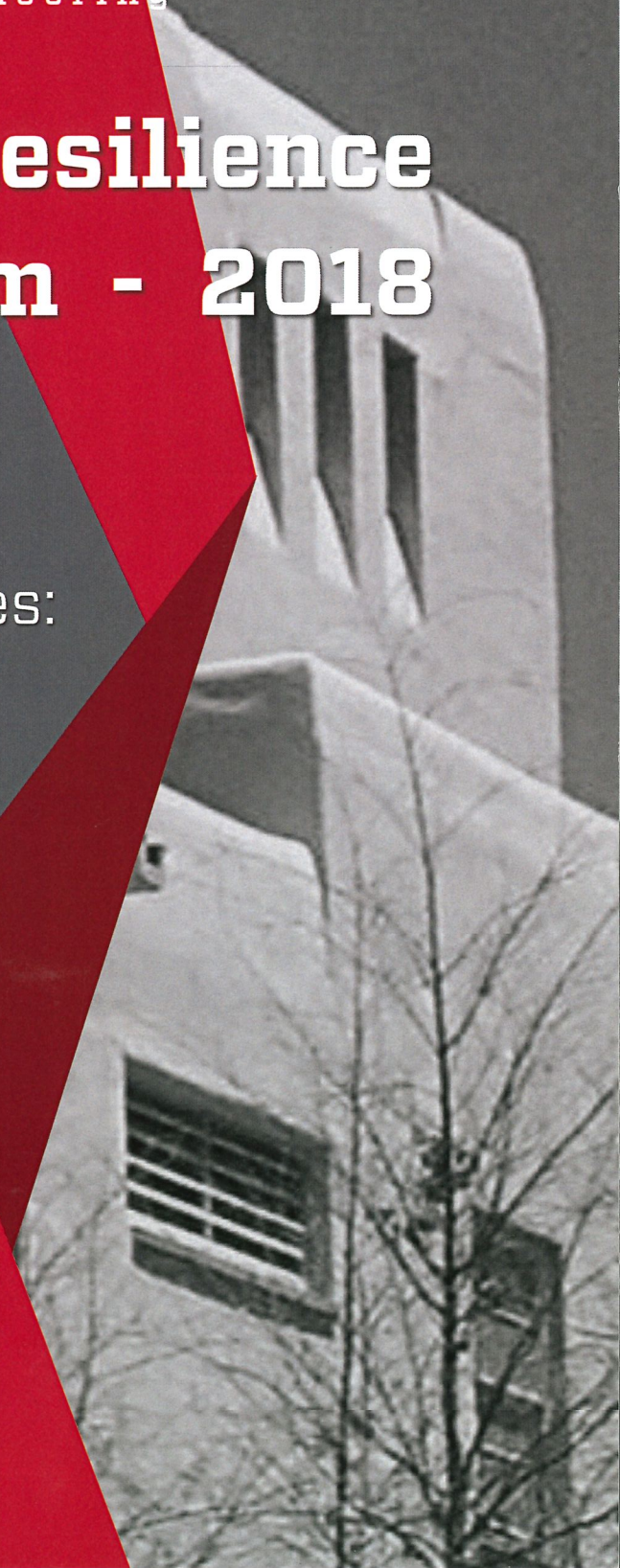
Centennial Engineering Center Auditorium
UNM School of Engineering

UNM RESILIENCE INSTITUTE

3rd UNM Resilience Colloquium - 2018

Challenges of Natural Stresses: Resilience Engineering for Natural and Built Environments

Albuquerque, New Mexico
August 8th – 9th, 2018



CIVIL, CONSTRUCTION & ENVIRONMENTAL ENGINEERING

Dear Colleagues,

It is our pleasure to welcome you to the Third Annual Resilience Colloquium by the University of New Mexico Resilience Institute addressing *Challenges of Natural Stresses: Resilience Engineering for Natural and Built Environments.* The third resilience colloquium aims to foster communication and collaboration between key researchers and stakeholders from across the country to address resilience as a national priority. Keynote presentations will be provided by researchers investigating resilience of U.S. communities exposed to wildfires in a changing climate in the Southwestern United States from Colorado State University, the University of New Mexico, and ICF. Other talks will cover resilience of the socio-ecological system and the resilience of headwater dependent systems from the U.S. Bureau of Reclamation, The Nature Conservancy, and Washington State University. We will then examine the role of emerging technologies including sensing and advanced materials on infrastructure resilience from the University of California at Berkeley and the University of New Mexico. We will also hear about experiences on community planning for urban resilience by researchers from The Nature Conservancy and Sandia National Laboratories.

The Third Annual Resilience Colloquium by the UNM Resilience Institute offers a communication forum for discussion and collaboration between government officials, researchers, engineers, planners, and scientists to engage in a fruitful discussion on resilience and the challenges of natural disasters. We hope you will find the time to benefit from the rich presentations and panel discussions. We welcome you all to the 2018 UNM Resilience Colloquium.

Colloquium Chairmen

Mahmoud Reda Taha, PhD, Peng
Distinguished Professor and Chair,
Department of Civil, Construction and Environmental Engineering
Founding Director, UNM Resilience Institute
The University of New Mexico

Mark Stone, PhD, PE
Associate Professor
Department of Civil, Construction and Environmental Engineering
New Director, UNM Resilience Institute
The University of New Mexico

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Wednesday, August 8th

7:00 am–8:00 am — **Check-In, Late Registration, and Continental Breakfast in Stamm Commons, Centennial Engineering Center**

8:00 am–8:30 am — **Opening Remarks and Colloquium Goals**

8:30 am–9:30 am — **Keynote Event (CEC Auditorium)**

Hussam Mahmoud, Colorado State University
Assessment of Community Vulnerability to Wildland Urban Interface Fires

9:30 am–10:30 am — **Session 1: Wildfire and Climate Change Impacts on Downstream Systems**

Vanessa Valentin, UNM
Quantifying the Impacts of Wildfire on the Built Environment for Risk Mitigation and Response Planning

Becky Bixby, UNM
Wildfire Impacts on Downstream Ecosystems

Cassandra Bhat and Brenda Dix, ICF
Climate Change Adaptation Guide for Transportation Systems Management, Operations, and Maintenance

10:30 am–11:00 am — **Networking and Coffee Break**

11:00 am–12:00 pm — **Panel 1: Impacts of Wildfires and Climate Change on Downstream Systems**

Hosted by: Becky Bixby and Jose Cerrato, UNM
Panelists: Vanessa Valentine, Hussam Mahmoud, Cliff Dahm and Johanna Blake

12:00 pm–1:00 pm — **Lunch and Presentation in Stamm Commons**

Josh Vertalka, Resilience Solutions 21
Communicating Urban Infrastructure Resiliency Models and Data to Diverse Stakeholders for Disaster Planning

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1:00 pm–2:15 pm	**Session 2: Building Resilience of Socio-Ecological Systems**
	Collin Haffey, The Nature Conservancy *Ideas for the Future of Forest Management*
	Dagmar Llewellyn, U.S. Bureau of Reclamation *Managing Risk and Resilience in the Upper Rio Grande Watershed*
	Jan Boll, Washington State University *Watersheds and Resilience Assessment*
2:15 pm–2:30 pm	**Networking and Coffee Break**
2:30 pm–3:45 pm	**Session 3: Resilience of Headwater Dependent Systems**
	Ryan Morrison, Colorado State University *Environmental Resilience of Floodplain Management*
	Ryan Webb, UNM *Sensitivity of Snowmelt Runoff Processes in the Colorado Rockies to a Changing Climate*
	Michael Bynum, Sandia National Laboratories *Open-Source Software for Water Distribution Resilience Analysis*
4:00 pm–4:45 pm	**Panel 2: Resilience of Headwater Dependent Systems**
	Hosted by: Ryan Webb, UNM *Panelists:* Dagmar Llewellyn, Collin Haffey, Jan Boll, Ryan Morrison, and Mark Stone
4:45 pm–5:00 pm	**Closing Remarks and Adjourn**

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Thursday, August 9th

7:00 am–8:00 am	**Breakfast in Stamm Commons**
8:00 am–9:00 am	**Keynote Event (CEC Auditorium)** Kenichi Soga, University of California, Berkeley *Smart Infrastructure and Construction*
9:00 am–10:45 am	**Session 4: Resilience of Infrastructure and Urban Systems** Mahmoud Taha, UNM *Effect of Redundancy on Resilience of Cable-Stayed Arch Bridges Under Extreme Events* CJ Unis, Sandia National Laboratories *My Personal Journey into Infrastructure Resilience & Complex Systems Thinking* Sarah Hurteau, The Nature Conservancy *Building Community through Conservation Projects* Michael Hightower, Sandia National Laboratories *Community Resilience Planning, Design, and Financing*
10:45 am–11:00 am	**Networking and Coffee Break**
11:00 am–12:00 pm	**Panel 3: Resilience of Infrastructure and Urban Systems** *Hosted by:* Mahmoud Taha, UNM *Panelists:* Kenichi Soga, Mike Hightower, Michael Bynum, CJ Unis, and Sarah Hurteau
12:00 pm–1:00 pm	**Lunch and Closing**

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ASSESSMENT OF COMMUNITY VULNERABILITY TO WILDLAND URBAN INTERFACE FIRES

Hussam Mahmoud

Associate Professor, Civil and Environmental Engineering, Colorado State University, Fort Collins, CO

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ABSTRACT

Recent wildland urban interface (WUI) fires have demonstrated the unrelenting destructive nature of these events and have called for an urgent need to address the problem. The consequences of these wildfires, particularly when interacting with communities, have resulted in substantial socio-economic losses all over the world. Therefore, there is an urgent need to quantify the vulnerability of communities to wildfires. While robust computational fluid dynamic models exist for simulating structure-fire interactions, their complexity and computational demand prevent their widespread application at the community scale. With advances in computational infrastructure, in the near future, the use of CFD models will become a reality. However, with the risk of WUI fires on an astronomic rise each year, we cannot afford to wait for the technology to match the research requirements. With this in mind, the pressing need lies in exploring alternative directions for quantifying WUI risk of communities. In this presentation a new probabilistic approach for quantifying community vulnerability to wildfires, using graph theory, is presented. The model accounts for relevant community-specific characteristics including wind conditions, community layout, individual structural features, and the surrounding wildland vegetation. The model is applied to a community to assess its vulnerability. The results show the most critical structures within the community with substantial dependency on meteorological conditions, environmental factors, and community characteristics and layout.

BIOGRAPHY

Hussam Mahmoud is an associate professor and the director of the structural laboratory at Colorado State University. His research interest focuses on deteriorated infrastructure, multi-hazard response of structures, community resilience.

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QUANTIFYING THE IMPACTS OF WILDFIRE ON THE BUILT ENVIRONMENT FOR RISK MITIGATION AND RESPONSE PLANNING

Vanessa Valentin

Assistant Professor, Department of Civil, Construction and Environmental Engineering,
University of New Mexico, Albuquerque, NM
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ABSTRACT

Communities are at risk of experiencing wildfire-related damage, whether directly from fire heat or from post-wildfire flash floods resulting from wildfire-induced changes to the watershed. During this talk, we discuss recent and current research in the Department of Civil, Construction and Environmental Engineering at the University of New Mexico in the area of wildfire impacts to the built environment. Specifically, we cover hazard assessments and vulnerability reduction retrofits for civil infrastructure and residential buildings respectively. An overview of proposed integrated frameworks for evaluating wildfire impacts, risk mitigation and response alternatives will be provided. Challenges and future research in this line of research will be also highlighted.

BIOGRAPHY

Dr. Valentin's research interests are in the area of construction engineering and management, with an emphasis on risk, asset and disaster management and sustainable construction. In addition, she is interested in studying the applicability, integration and improvement of analytical and modelling methods for solving decision-making problems in the built environment and considering non-technical aspects of such decisions. She holds a PhD and a MSCE from Purdue University and a BSCE from the University of Puerto Rico at Mayagüez.

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EFFECTS OF WILDFIRES ON AQUATIC ECOSYSTEMS

Rebecca J. Bixby

Research Assistant Professor and Associate Director, Department of Biology and Water Resources Program, University of New Mexico, Albuquerque, NM
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ABSTRACT

Fire is a prevalent feature of arid landscapes and has complex effects on geological, hydrological, ecological, and economic systems. In the southwestern U.S., the frequency and intensity of wildfires have increased in recent years and are projected to escalate with predicted climatic and land use changes. The complexities of fire as a disturbance shaping freshwater ecosystems will be discussed, using collaborative research resulting from the Las Conchas fire as a case study.

In north-central New Mexico, the Las Conchas wildfire burned > 150,000 acres in 2011, impacting the surrounding aquatic ecosystems. The acute fire impacts in the Jemez River and downstream Rio Grande watersheds were driven by monsoonal rain events resulting in pulse flows, elevated turbidity and nutrients, and depressed dissolved and pH levels. Aquatic biological communities were also affected by elevated turbidity and nutrients and increased sedimentation. Discharge and water quality data during the monsoons preceding the fire (2010) showed no disturbance linkage among rain events, flow, and water quality while similar data the following year (2012) provide evidence of chronic water quality impacts. Multiple research approaches have focused on both the short-term and long-term impacts of this fire in terms of water quality (and the mechanisms drive water quality change), functional ecosystem responses, and the structure of the aquatic biological communities in terms of their differential resistance and resilience to wildfire disturbances. This collaborative work to understand the effects of wildlife at different temporal and spatial scales continues to inform pre- and post-fire management and restoration strategies.

BIOGRAPHY

Rebecca Bixby is research faculty in the Biology Department and the Associate Director of the UNM Water Resources Program at the University of New Mexico. Bixby's research group focuses on the response, including resistance and resilience, of aquatic organisms and food web structure to natural and anthropogenic stressors including fire, extreme hydrographs, and disturbance. Bixby has a PhD from the University of Michigan in Natural Resources.

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CLIMATE CHANGE ADAPTATION GUIDE FOR TRANSPORTATION SYSTEMS MANAGEMENT, OPERATIONS, AND MAINTENANCE

Cassandra Bhat and Brenda Dix

Manager, Climate Adaptation and Resilience, ICF, USA
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ABSTRACT

This presentation will provide an overview of the FHWA Climate Change Adaptation Guide for Transportation Systems Management, Operations, and Maintenance. The guide provides information and resources to help transportation management, operations, and maintenance staff incorporate climate change into their planning and ongoing activities. It is intended for practitioners involved in the day-to-day management, operations, and maintenance of surface transportation systems at State and local agencies. The guide assists State departments of transportation (DOTs) and other transportation agencies in understanding the risks that climate change poses and actions that can help reduce those risks. Incorporating climate change considerations into how agencies plan and execute their transportation system management and operations (TSMO) and maintenance programs helps the agency become more resilient to unanticipated shocks to the system. Adjustments to TSMO and maintenance programs – ranging from minor to major changes – can help to minimize the current and future risks to effective TSMO and maintenance.

BIOGRAPHY

Cassie Bhat has over eight years of experience helping organizations integrate climate change risks and opportunities into their existing processes, particularly in the transportation sector. She is working with State DOTs to assess the vulnerability of their transportation infrastructure and integrate that understanding into their asset management plans and operations. She has worked with FHWA since 2010 to develop guidance, tools, and other resources to support State DOT resilience efforts, including the Gulf Coast Study Phase 2, the DOT Vulnerability Assessment Scoring Tool, and the Climate Change Adaptation Guide for Transportation Systems Management, Operations, and Maintenance.

Brenda Dix has nine years of experience assessing transportation asset vulnerability to extreme weather and climate change through her work at a regional transportation agency in the San Francisco Bay Area and through her work with federal and local governments while at ICF. She has worked with the Federal Highway Administration (FHWA) and is currently managing a project to develop an implementation guide for nature-based solutions for coastal highway resilience, and she helped coordinate and facilitate peer exchanges for Climate Resilience Pilots to advance best practices and develop a community of practice.

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COMMUNICATING URBAN INFRASTRUCTURE RESILIENCY MODELS AND DATA TO DIVERSE STAKEHOLDERS FOR DISASTER PLANNING

Josh Vertalka

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ABSTRACT

Effective disaster management often requires insight from highly complex models that analyze a myriad of infrastructure issues and dependencies before, during, and after a disaster. These models act as the backbone in the decision-making and planning process but can sometimes become obscured for those who need them the most. Coupling advanced modeling techniques with intuitive visualizations creates easily accessible and digestible information for disaster managers allowing them to make better planning decisions. As such, this presentation discusses the importance of effectively communicating advanced economic, physical, and social models and data from RS21, national laboratories, universities, and the private sector to a diverse set of stakeholders for disaster planning.

BIOGRAPHY

Dr. Josh Vertalka is the Chief Data Scientist (CDS) at RS21. He has published in top peer-reviewed scientific journals and taught college level courses. Josh leverages expert level geography, geostatistical, and urban planning knowledge to create world-class actionable insights from even the most obtuse data sets. He also has extensive experience with social media data for predictive analytics in the healthcare industry. As RS21's CDS, it is Josh's responsibility to ensure all data related matters meet the highest level of sophistication and scientific rigor.

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IDEAS FOR THE FUTURE OF FOREST MANAGEMENT

Collin Haffey

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ABSTRACT

Foresters are beset by unsolvable problems. Climate change is driving unprecedented and irreversible change in ecosystems where forests have been managed for sustainability. Efforts to restore forests to the composition and structure that will support fire regimes that characterized previous centuries are running up against limitations of time, money, and administrative capabilities.

Forest ecology and management must respond to this set of challenges. Doing so will increasingly require planning for and managing landscapes a mosaic of mature and regenerating forest, scrubland, grassland, and human-dominated habitats. Strategies are beginning to emerge for developing sound management for tomorrow's forested landscapes. These include techniques for drawing on extensive empirical studies to develop new, practical models to guide planning. Few of today's quantitative models capture the dynamics of the post-fire environment sufficiently to forecast future conditions. Additional, mitigation efforts, in some cases will help move a post-fire system toward a desired novel state, when reforestation to the pre-fire forest type in impractical or impossible. Examples of these strategies include assisted migration and additional post-fire fuels reduction. It is no longer possible to separate the forest from the larger landscape. Social values, economic prosperity, and community needs dictate a broader focus, where foresters are working to balance diverse and increasingly important needs, including community protection, watershed protection, carbon sequestration, and the conservation of biodiversity.

BIOGRAPHY

Collin Haffey is the conservation coordinator with The Nature Conservancy in New Mexico, where, among other things, he works to support the Rio Grande Water Fund. Before joining TNC, Collin worked on climate-related forest disturbance processes, ranging from drought- and fire-induced ecosystem type conversion from forests to shrublands or grasslands at local and regional scales. He is currently co-organizing a large collaborative climate change adaption project in the Jemez Mountains.

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MANAGING RISK AND RESILIENCE IN THE UPPER RIO GRANDE WATERSHED

Dagmar Llewellyn

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ABSTRACT

This presentation will review the risks to and stresses on the Upper Rio Grande watershed through a resilience lens, along with ways that the resilience of this complex, multi-faceted social-ecological system might be enhanced. Disturbances are a critical component of the health of many components of our water system, but also contribute risks, especially as these disturbance regimes change, due either to human development or our changing hydroclimatic conditions. Threats exist to the basic structure and function of ecological components of the watershed, including upland forests where snowpacks build, rivers in which water is conveyed downstream where it can be used to meet human needs, and riparian systems that both enhance and constrain the rivers. But opportunities also exist to enhance the resilience of these system components, or manage their inevitable transformations into novel ecosystems. Disturbances also threaten human infrastructure, including dams, reservoirs, diversions, and irrigation networks, many of which were designed to under hydrologic and climatic conditions that differ from those that we see today, and are likely to see in the future. The resilience lens affords an opportunity to evaluate which of this infrastructure will best serve us in the future.

BIOGRAPHY

Dagmar Llewellyn has served as a hydrologist at the Bureau of Reclamation office in Albuquerque since 2010. At Reclamation, she coordinates projects related to the projection of the impacts of climate change, and to building of resilience to resulting changes in our watersheds and water supply. She provides her expertise to endangered species and other environmental compliance in the Rio Grande Basin, as well as to research and outreach efforts related to water supply and demand challenges in the Rio Grande basin. She also serves as the Science & Technology Program coordinator for Reclamation's Upper Colorado Region. She is also an adjunct faculty at the University of New Mexico, where she has taught water-related courses in several departments, and serves on thesis committees.

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WATERSHEDS AND RESILIENCE ASSESSMENT

Jan Boll

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ABSTRACT

Human population growth and development combined with climate change have placed increased stresses on water, energy and agricultural resources. Internationally, human communities rely on water storage from glaciers, snowpack, and groundwater in headwater watersheds. Vulnerability of downstream communities depends upon the direction and magnitude of hydrologic change and on their ability to adapt. Concerns over food, energy and water security and the need to be able to withstand future disturbances and shocks (i.e., resilience) require careful management of storage resources. A working hypothesis is that coordinated management of physical (e.g., reservoirs, aquifers, and batteries) and non-physical (e.g., water markets, social capital, and insurance markets) storage systems across the three sectors promotes resilience. Coordination increases effective storage of the overall system and enhances buffering against shocks at multiple scales (e.g., heat waves, droughts, long-term snowpack declines), and can be augmented with innovations in technology (e.g., smart systems and energy storage) and institutions (e.g., economic systems and water law). The presentation will show example strategies and ideas drawing from 1) a current NSF INFEWS project in the Columbia River Basin, 2) a new NSF CNH-RCN on understanding headwater dependent system resilience to environmental change in multiple watersheds across a latitudinal Transect of the Americas, and 3) from a resilience practice perspective.

BIOGRAPHY

Co-PI on NSF INFEWS grant: “Increasing Resilience Across the Food, Energy, and Water Sectors in the Columbia River Basin”. Future PI on NSF CNH-RCN grant: “A Research Network for the Resilience of Headwater Systems and Water Availability for Downstream Communities Across the Americas”. At University of Idaho (< 2015): Director of the Waters of the West Program, Water Resources Program, Environmental Science Program, Professional Science Masters Program, lead scientist of UI EPSCoR MILES project, and PI on NSF-IGERT.

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ENVIRONMENTAL RESILIENCE OF FLOODPLAIN MANAGEMENT

Ryan R. Morrison

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ABSTRACT

Floodplains provide numerous ecosystem services, including the storage of surface and subsurface water, floodwave attenuation, and a source of energy and nutrients for riverine ecosystems. These services depend on natural river-floodplain connectivity, which has been altered due to human development within floodplains. Resilient management of rivers and floodplains requires understanding the cumulative impact of development on connectivity, linking loss of connectivity to specific floodplain functions, and identifying opportunities for restoration and improved management frameworks. Furthermore, tools are needed to assess the resiliency and vulnerability of floodplain functions to human modifications. In this presentation, I briefly discuss new models and approaches for examining changes in floodplain connectivity and implications for floodplain resilience. Specifically, I present studies for 1) a hydrogeomorphic floodplain delineation model used to identify floodplains and examine loss of floodplain connectivity due to levees, and 2) a conceptual framework to quantifying floodplain integrity. These studies focus on floodplain management at large scales, which has traditionally been neglected in favour of reach-scale management. This line of research will be informative for floodplain management in both rural and urban areas, including river restoration activities and groundwater management.

BIOGRAPHY

Ryan Morrison is a water resources engineer and assistant professor at Colorado State University in the Civil and Environmental Engineering Department. The majority of his research is focused on sustainably integrating ecological and human needs into water resource management, both from engineering and social science perspectives. His work emphasizes the impacts of river management on aquatic ecosystems and explores new methods for mitigating management effects.

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SENSITIVITY OF SNOWMELT RUNOFF PROCESSES IN THE COLORADO ROCKIES TO A CHANGING CLIMATE

Ryan W. Webb

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ABSTRACT

An important consideration for water resource planning is snowmelt runoff timing and hillslope-stream connectivity. These factors can be determined by the difficult to observe physical process of water movement through a seasonal snowpack. The aim of this study is to present a novel method that combines light detection and ranging (LiDAR) with ground penetrating radar (GPR) to non-destructively observe the spatial distribution of bulk liquid water content in a seasonal snowpack during spring snowmelt. We develop these methods in a manner to be applicable within a short time window, making it possible to spatially observe rapid changes that occur to this property (sub-daily timescale). We applied these methods at three experimental plots across elevational gradients in Colorado, showing the high variability of liquid water content in snow. Volumetric liquid water contents ranged from near zero to 19% within the scale of meters. We also show the rapid changes in bulk liquid water content that occur over sub-daily time scales. Results of this study show the importance of the lateral flow of water in higher elevation snowpacks and how the scale of this process changes across an elevational gradient. In a future climate, headwater snowpacks may see changes in intra-snowpack flowpaths and hillslope-to-stream connectivity. This will decrease runoff ratio due to the increased surface water-groundwater interactions.

BIOGRAPHY

Dr. Ryan Webb has recently been hired as an Assistant Research Professor at UNM. Dr. Webb's research interests include snow and mountain hydrologic processes through applied fluid mechanics, unsaturated physics of complex porous media, thermodynamics, and vadose zone hydrology. He uses a combination of approaches including field observations, numerical modelling, geophysics, and applied tracer experiments. Additional interests include hydrologic impacts of land use and land cover changes in headwater systems (i.e., forest fire), and water resources in developing countries.

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OPEN SOURCE SOFTWARE FOR WATER DISTRIBUTION RESILIENCE ANALYSIS

Michael Bynum

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ABSTRACT

Drinking water systems face multiple challenges, including aging infrastructure, water quality concerns, uncertainty in supply and demand, natural disasters, environmental emergencies, and cyber and terrorist attacks. All of these incidents have the potential to disrupt a large portion of a water system causing damage to critical infrastructure and interrupting service to customers. Simulation and analysis tools can help water utilities better understand how their system would respond to a wide range of disruptive incidents and inform planning to make systems more resilient over time. The Water Network Tool for Resilience (WNTR) is a new open source Python package designed to meet this need. WNTR integrates hydraulic and water quality simulation, a wide range of damage and response options, and resilience metrics into a single software framework, allowing for end-to-end, customizable evaluation of water network resilience and prioritization of resilience-enhancing actions. WNTR includes capabilities to 1) generate and modify water network structure and operations, 2) simulate disaster scenarios, 3) model response and repair strategies, 4) simulate hydraulics and water quality, 6) calculate resilience metrics and 7) visualize results. The U.S. Environmental Protection Agency and Sandia National Laboratories are working with water utilities to ensure that WNTR can be used to efficiently evaluate resilience under different use cases. This talk will include discussion on WNTR capabilities, water utility case studies, and resources to help get new users started using the software.

BIOGRAPHY

Michael Bynum is a PhD candidate at Purdue University and intern at Sandia National Laboratories. His research interests include optimization algorithms (mixed-integer nonlinear programming algorithms in particular) and critical infrastructure resilience. Michael is one of the developers of the Python package WNTR (Water Network Tool for Resilience) and does research on the use of stochastic programming for improving electric grid resilience.

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SMART INFRASTRUCTURE AND CONSTRUCTION

Kenichi Soga

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ABSTRACT

Design, construction, maintenance and upgrading of civil engineering infrastructure requires fresh thinking to minimize use of materials, energy and labor, but at the same time to be resilient against hazards. This can only be achieved by understanding the performance of the infrastructure, both during its construction and throughout its design life, through innovative monitoring. Advances in sensor systems offer intriguing possibilities to radically alter methods of condition assessment and monitoring of infrastructure. In this talk, it is hypothesized that the future of infrastructure relies on smarter information; the rich information obtained from sensors within infrastructure will act as a catalyst for new design, construction, operation and maintenance processes for integrated infrastructure systems linked directly with user behavior patterns. Some examples of emerging sensor technologies for infrastructure sensing are given. They include distributed fiber-optics sensors, computer vision, wireless sensor networks, low-power micro-electromechanical systems, energy harvesting and citizens as sensors.

BIOGRAPHY

Kenichi Soga is a Chancellor's Professor at the University of California, Berkeley. He obtained his BEng and MEng from Kyoto University in Japan and PhD from the University of California at Berkeley. He was Professor of Civil Engineering at the University of Cambridge before joining UC Berkeley in 2016. While at Cambridge, he and his colleagues initiated the Centre for Smart Infrastructure and Construction (www-smartinfrastructure.eng.cam.ac.uk). The strategic aim of CSIC is that emerging technologies from its pioneering research will transform the construction industry through a whole-life approach, achieving sustainability in construction and infrastructure in an integrated way. He has published more than 350 journal and conference papers. His current research activities are Infrastructure sensing, Performance based design and maintenance of infrastructure, Energy geotechnics, and Geotechnics from micro to macro. He is a Fellow of the UK Royal Academy of Engineering and a Fellow of the Institution of Civil Engineers. He is recipient of many awards including George Stephenson Medal and Telford Gold Medal from the Institution of Civil Engineers and Walter L. Huber Civil Engineering Research Prize from the American Society of Civil Engineers.

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EFFECT OF REDUNDANCY ON RESILIENCE OF CABLE-STAYED ARCH BRIDGES UNDER EXTREME EVENTS

Mahmoud Reda Taha

Distinguished Professor, Department of Civil, Construction and Environmental Engineering,
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ABSTRACT

Critical infrastructure and lifeline systems are typically designed for reliable response under heavy service loading. However, when exposed to natural multi-hazard events such as the 2017 Mexico earthquakes and/or the Florida and Puerto Rico Hurricanes, those infrastructure systems become vulnerable and the consequence of their collapse can be catastrophic. The evolving concept of resilience is of great importance to design engineers to consider system ability to maintain a certain level of functionality after being subjected to extreme events. Despite its importance and being one of the four key components in resilience measure, current metrics of infrastructure resilience do not explicitly account for structural redundancy. In this work, the methodologies and frameworks for resilience assessment are reviewed and applied to a cable-stayed arch bridge system. The bridge is subjected to multiple earthquake signals coupled with scouring due to flood. Redundancy is introduced by varying the number of cables in the bridge system and is quantified for each system using pushdown analysis. Fragility curves are produced using a nonlinear time-history analysis to assess the vulnerabilities of the systems and evaluate resilience. The results provide an insight into the resilience of cable-stayed arch bridge systems with different levels of redundancy when subjected to combined extreme events.

BIOGRAPHY

Mahmoud Reda Taha is Distinguished Professor and Chair of Department of Civil, Construction and Environmental Engineering at University of New Mexico. He is Co-Chair of ASCE Committee on Emerging Technologies for Infrastructure Resilience. His Research interests include using nanomaterials, structural monitoring and 3D printing technologies for developing a new generation of resilient infrastructure.

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MY PERSONAL JOURNEY INTO INFRASTRUCTURE RESILIENCE & COMPLEX SYSTEMS THINKING

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ABSTRACT

We live in a complicated and complex world. Social systems, human systems, physical systems, and critical infrastructure all come together and affect our daily experiences, and the rapid advancement of technologies increases the interconnectedness and rapidity at which consequences propagate through the modern world. To truly understand infrastructure resilience, one needs to approach this challenge with a complex systems mentality.

This statement reflects my current perspective as a Systems Engineer at Sandia National Laboratories. My current research has certainly affected this perspective, but my diverse and varied professional experiences have also had a profound effect on reaching this perspective. In this talk, I will describe my personal and professional experiences as a U.S Marine, Federal Agent for the Office of Secure Transport, Critical Infrastructure Program Manager for the State of New Mexico's Department of Homeland Security and Emergency Management, and Systems Engineer at Sandia and how they have shaped my perspective on the importance of complexity when studying infrastructure resilience.

BIOGRAPHY

Carl "C.J." Unis is a Systems Engineer at Sandia National Laboratories. He conducts research and data analysis for Systems Research, Analysis & Applications. He has a Master's Degree in Systems Engineering from the Stevens Institute of Technology. He has over 15 years of professional experience in various disciplines.

The University of New Mexico
3rd Annual Resilience Colloquium

Challenges of Natural Stresses:
Resilience Engineering for Natural
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BUILDING COMMUNITY THROUGH CONSERVATION PROJECTS

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ABSTRACT

The Nature Conservancy New Mexico launched its urban conservation program in 2016 with a vision to redefine how natural systems and urban communities interact by creating an Albuquerque metro area that is prosperous, environmentally sound, and provides a high quality of life for all residents. Our program aims to: 1) Reduce heat impacts; 2) Support people and biodiversity with Nature's provision of water; and 3) Build a culture of stewardship that is diverse and inclusive. Building on the success of the Rio Grande Water Fund, the Urban Program has expanded existing community engagement efforts and local partnerships into the urban setting to demonstrate nature-based solutions that address pressing conservation issues in our region. Fundamental to this approach is reaching out to new groups of people to broaden our constituency and prioritize areas to work that embody the idea of nature for people and people for nature.

Over the last two years, we have engaged with dozens of organizations to meet our local conservation objectives while simultaneously bridging to social needs at a neighborhood scale. Our spatial analysis focused on heat stressed neighborhoods has also brought to light the differences in socioeconomics across Albuquerque and the resulting challenges communities face in addressing these environmental issues. Our approach to urban resiliency encompasses not only the ecological context, but also the social aspects of these challenges.

BIOGRAPHY

As the Urban Conservation Director for TNC in New Mexico, Sarah is working to redefine how urban communities interface with natural resources, creating an Albuquerque metro area that is prosperous and environmentally sound. Her training as a wildlife biologist informs her urban work, bringing ecological concepts of habitat restoration into the urban setting through on the ground projects showcasing nature-based solutions. Sarah holds a B.S. in Wildlife, Fish and Conservation Biology from the University of California, Davis and a M.S. in Environmental Science and Policy form Northern Arizona University.

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COMMUNITY RESILIENCE PLANNING, DESIGN, AND FINANCING

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ABSTRACT

Community and infrastructure resilience has been defined as the ability to prepare for and adapt to changing conditions and withstand and recover rapidly from disruptions including accidents, natural disasters, or deliberate attacks. Recent efforts by federal agencies to help improve urban resiliency have shown that the regional and community social, economic, and critical services and infrastructure resilience needs and priorities can vary greatly. Therefore, resilience analysis and design approaches are needed that enable communities to evaluate, plan, design, implement, and finance resilience improvements to address community-specific critical social, economic, and infrastructure priorities and interdependencies efficiently and cost-effectively.

This presentation will discuss some of the unique system-level, critical services, and infrastructure interdependency issues of urban communities that make them so hard to assess and quickly upgrade. It will include major considerations in defining and creating a resilient community, common limitations of current resiliency approaches, and the use of performance-based resiliency modeling and analysis approaches to help communities identify and develop conceptual designs, and then plan and finance the required upgrades. The presentation will highlight lessons learned from resiliency evaluation and planning efforts undertaken over the past decade at over 30 civilian and military communities across the country, including communities impacted by large natural disasters like Hurricanes Harvey, Katrina, Irma, Maria, and Super Storm Sandy.

BIOGRAPHY

Mike recently joined the University of New Mexico after 38 years at Sandia National Laboratories, working in the areas of weapons research, natural resources security and sustainability, infrastructure security, and research on energy and water infrastructure assurance and resiliency. Mike has published over 120 technical papers and reports, including three book chapters, three Reports to Congress, and an article in Nature.

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Thank you to all our attendees for participating in our interdisciplinary discussion and sharing of ideas for solutions in Resilience Engineering.

Special thank you to our sponsor for providing this opportunity to learn and share.

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