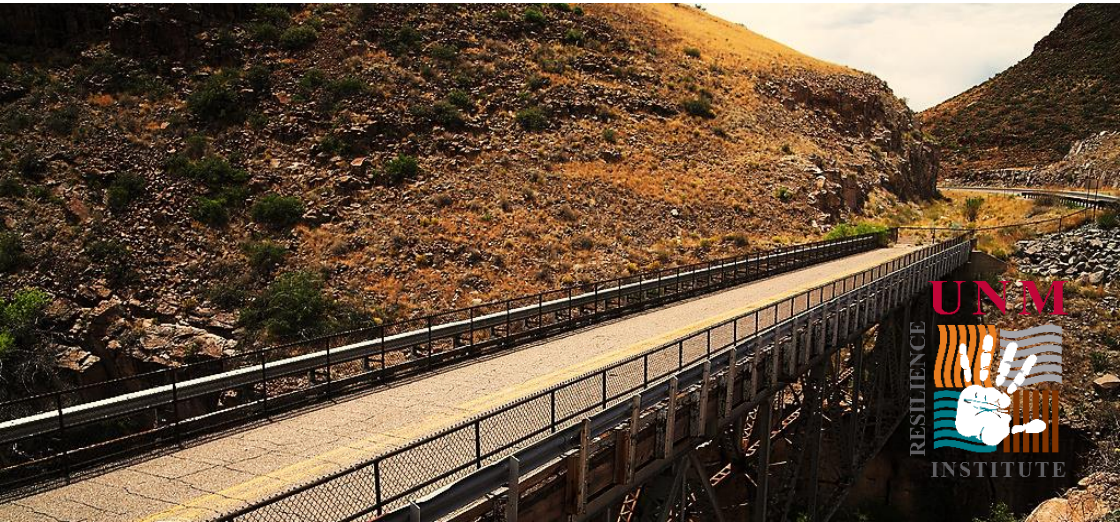
BOOK OF ABSTRACTS

# University of New Mexico
## First Resilience Colloquium

*May 10, 2016*



UNM RESILIENCE INSTITUTE

**Dear Colleagues,**

This is the first academic colloquium on resilience to be held by the University of New Mexico. It is also the first event organized by UNM Resilience Institute, a new Research Centre at UNM with the objective of integrating UNM research and educational efforts on Resilience and serving the City of Albuquerque, The State of New Mexico, and at the national level for identifying resilient development solutions. Resilience concepts are interdisciplinary by nature and include the fields of science, engineering, computing, economics, ecology, geography, anthropology, psychology, community planning, management, and law among others. Within these various disciplines, there are a number of working definitions of resilience. We aim to actively engage these differences and build on this diversity while also creating a shared vision for enabling resilient communities. Ultimately, we aim to promote transdisciplinary research to advance resilient infrastructure as a basic national priority.

The National Academies of Science and Engineering, in its report "*Disaster Resilience: A National Imperative*", expressed the need to consider resilience as a national priority. The challenge of increasing national resilience has been recognized by the US federal government, including eight federal agencies and the national laboratories, and it is now considering the broad issue of increasing national resilience. UNM Resilience Institute comes in response to this national need, and plans to help the nation move from a reactive approach to disasters, to a proactive stance. With its own growing population and potential for disaster, specifically droughts, wildfires and flash floods, New Mexico and the southwestern United States is a bellwether for worldwide trends in disaster resilience and an ideal location for a strong, collaborative research program focused on resilience integrating the university, national labs and the private sector. With all the above in mind, this colloquium is focused on highlighting research, methods, and opportunities necessary for realizing resilient communities.

This colloquium is designed to engage all faculty in UNM, our industry partners and national laboratories involved in the field of resilience and to bring to the core of our discussions contributions from all schools and institutions across campus. This is reflected by the list of contributing faculty across a wide spectrum in UNM including School of Engineering, College of Arts and Science, School of Law, School of Architecture and Planning, Anderson School of Management as well as UNM Health Sciences Center. The colloquium is focused on three areas of resilience: water and the environment with its mega size impact on the New Mexico community, social aspects, data analysis and visualization, and infrastructure. I hope you find this activity of interest to you. We invite you to attend this colloquium and to take an active part in the upcoming events and research efforts by UNM Resilience Institute. This book of abstracts presents a plethora of collective knowledge on resilient infrastructure that is discussed in the colloquium through its participants.

**Colloquium Chairman**

**Mahmoud Reda Taha, PhD, PEng**
**Professor and Chair, Department of Civil Engineering**
**Director, UNM Resilience Institute**
**University of New Mexico**

# University of New Mexico
# First Resilience Colloquium

## May 10, 2016

8:30 AM **Opening:** Chaouki Abdallah, Provost, University of New Mexico
8:45 AM **Welcome:** Joe Cecchi, Dean, UNM School of Engineering

**Session 1: Session Chairman: Eric Vugrin (Sandia National Laboratories)**

1 9:00 AM ***Resilience: A research paradigm for the Anthropocene***
*Mindy Benson, Department of Geography and Environmental Studies, UNM*

2 9:20 AM ***Water governance and resilience in the Orange-Senqu river basin***
*Elizabeth J. Kistin Keller, Sandia National Laboratories*

3 9:40 AM ***Resilience theory applied to water infrastructure projects***
Mark Stone, Civil Engineering, UNM

4 10:00 AM ***Transportation planning for more resilient communities***
Gregory Rowangould, Civil Engineering, UNM

**10:30 AM Coffee Break**

**Session 2: Session Chairman: Chris Lippitt (UNM Geography & Environmental Studies)**

5 11:00 AM ***Disaster law and resilience***
Marsha Baum, UNM School of Law

6 11:20 AM ***Charter cities, institutional selection, and global resilience***
Manuel Montoya, UNM Anderson School of Management

7 11:40 AM ***The economics of water and fire: An optimal control perspective***
Jingjing Wang, Department of Economics, UNM

**12:00 PM Lunch Break - *The Global Resilience Movement*** Charles Rath, RS21

**Session 3: Session Chairman: Tim Castillo (UNM School of Architecture and Planning)**

8 1:00 PM ***Topological survivability of networks for resilience analysis of critical infrastructure*** Svetlana Poroseva, Mechanical Engineering, UNM

9 1:20 PM ***Big Data: Bridging scalability and resiliency for analytics***
Trilce Estrada, Computer Science, UNM

10 1:40 PM ***Cyber-physical systems for resilient infrastructure***
Meeko Oishi, Electrical and Computer Engineering, UNM

**2:00 PM Coffee Break**

**Session 4: Session Chairman: Brady Horn (UNM Department of Economics)**

11 2:30 PM ***Probabilistic characterization of cascading failures in electric-cyber infrastructure*** Majeed Hayat, Electrical and Computer Engineering, UNM

12 2:50 AM ***Resilience-based assessment of wildfire: Impacts on built and natural civil infrastructure*** Vanessa Valentine, Civil Engineering, UNM

13 3:10 PM ***Improving infrastructure resilience assessment using structural health monitoring data*** Mahmoud Reda Taha, Civil Engineering, UNM

**3:45 PM Adjourn**

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# RESILIENCE: A RESEARCH PARADIGM FOR THE ANTHROPOCENE

**Melinda Harm Benson**

Associate Professor and Associate Chair, Department of Geography and Environmental Studies, University of New Mexico, Albuquerque, NM, USA, mhbenson@unm.edu

## ABSTRACT

There is a pressing need to reconceptualize both our thinking about and our relationship to environmental and natural resource challenges. We must face the emerging realities of the Anthropocene, which include unprecedented and irreversible rates of human-induced biodiversity loss, exponential increases in per-capita resource consumption, and global climate change.

Combined, these and other factors are increasing the likelihood of rapid, non-linear, social and ecological regime changes. New research paradigms and policy orientations are needed to provide the necessary capacity to deal with these "wicked problems" in a meaningful and equitable way. This paper posits that the concept of "resilience" is emerging as an emerging concept in both scholarly literature and policy discussions that has potential in this regard.

After first situating resilience thinking within current and historical ways of thinking about social-ecological systems, Benson examines the potential for resilience to shift the existing paradigm.

***BIOGRAPHY**: Melinda Harm Benson is an Associate Professor in the Department of Geography and Environmental Studies at the University of New Mexico. Her research and teaching center on environment and natural resource management challenges, with a particular emphasis on emerging trends in environmental governance.*

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# WATER GOVERNANCE AND RESILIENCE IN THE ORANGE-SENQU RIVER BASIN

**Elizabeth J. Kistin Keller, PhD**

Systems Analyst, Systems Analysis & Decision Support, Sandia National Laboratories, Albuquerque, New Mexico, USA, *ejkisti@sandia.gov*

Adjunct Professor, Geography & Environmental Studies, University of New Mexico, Albuquerque, New Mexico, USA

## ABSTRACT

Climatic characteristics, population growth, economic development and changing resource management practices contribute to continuously changing patterns of water flow and utilization in the Orange-Senqu basin of southern Africa. Conventional wisdom suggests that cooperation between riparian countries will improve governance and increase resilience by allowing countries to recognize and respond to changing circumstances in the basin through data collection, exchange, and utilization and joint planning and policy implementation.

This study focuses on four core components of resilience in transboundary basins: institutional flexibility, information management, actor networks and financial resources. Document analysis and in-depth interviews are used to trace changes in these four components between 1980 and 2008, determine the extent to which changes were caused by regime performance or other factors, and assess the underlying determinants affecting the performance of the Orange-Senqu water governance regime.

The analysis shows that the Orange-Senqu water regime has both enabled and constrained resilience in the basin. While international water management institutions and riparian interactions have made valuable contributions to information exchange and joint planning, discursive structures limiting the scope of discussion in the basin-wide forum, ORASECOM, constrain the parties' abilities to recognize and respond to changing circumstances and engage in joint planning at the basin scale. These findings suggest that efforts to envision and influence change in the basin will require a firm understanding of the power-laden, multi-layered processes influencing the negotiation and implementation of transboundary water governance regimes.

***BIOGRAPHY**: Elizabeth J. Kistin Keller received her Ph.D. in International Development (Political Science, Economics, and Anthropology) as a Rhodes Scholar at Oxford University. Elizabeth currently works in the Systems Analysis & Decision Support Department at Sandia National Labs where she focuses on global security studies, policy analytics, strategic foresight and decision support.*

**RESILIENCE THEORY APPLIED TO WATER INFRASTRUCTURE PROJECTS**

University of New Mexico
First Resilience Colloquium

May 10, 2016

**Mark Stone**

Associate Professor, Department of Civil Engineering, University of New Mexico, Albuquerque, New Mexico, USA, *stone@unm.edu*

## ABSTRACT

Traditional approaches for designing, implementing, and managing water resources development projects have taken a relatively narrow view when defining project success. For example, project performance is often viewed from a *design life* perspective – focused on an often arbitrarily-defined performance period. This is in contrast to the *life cycle management* perspective, which include a systematic set of procedures for compiling and examining the inputs and outputs of materials and energy, as well as the social and environmental impacts associated with the functioning of the product, throughout its life cycle. A major feature of the life cycle management approach to water infrastructure is the engineering and economic planning for decommissioning or long-term maintenance beyond the design life, a task and economic burden that many consider unethical to defer to future generations who did not enjoy the benefits of the infrastructure. In addition, a holistic assessment of the costs and benefits of a project though the life cycle lens requires a broader definition of the system. For example, water resources development projects can contribute to direct and indirect impacts on social and ecological systems in ways that extend beyond the tools of traditional engineering economics. In order to evaluate the success of a project through a resilience perspective, the impacts of the project through a life-cycle approach on the resilience of surrounding communities and ecosystems should also be considered. The objective of this paper is to investigate alternative methods for incorporating resilience and socio-ecological systems (SES) theory across the life cycle of water infrastructure projects.

***BIOGRAPHY**: Mark Stone, PhD, Associate Professor, UNM Civil Engineering. He received his Ph.D. from the Washington State University in 2005. His research interests include water resources management, environmental flows, and resilience to natural disasters.*

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# TRANSPORTATION PLANNING FOR MORE RESILIENT COMMUNITIES

**Gregory Rowangould**

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## ABSTRACT

The transportation systems that our communities depend on for mobility also contribute to a wide range of demanding societal challenges. The transportation system in the United States emits a third of all greenhouse gas emissions and a large mixture of toxic air pollutants including many known carcinogens. The transportation system is also extremely dangerous, killing 33,804 people in the U.S. last year alone. Furthermore, our transportation system has evolved to rely increasingly on the use of personal motorized vehicles, marginalizing those who cannot afford to use them and contributing to a public health crisis born from our increasingly sedentary lives. It has become apparent that our transportation systems threaten the sustainability of modern life.

Despite the widespread attention that these issues have received, little has been accomplished. The long range (20 to 30 year) transportation plans that must be created by all metropolitan areas in the U.S. at best contain incremental improvements while most simply reflect the status quo. If we cannot create plans that respond to well-known problems over a span of two or three decades how can we possibly respond to the unexpected?

In this talk, I discuss how creating a resilient transportation planning process that is more responsive and adaptable can help us maintain the vitality of our communities in the face of a rapidly changing world while also providing a path towards greater sustainability.

***BIOGRAPHY**: Gregory Rowangould, PhD, Assistant Professor, UNM Civil Engineering. He received his Ph.D. from the University of California, Davis in 2010. His research interests include mobile source air pollution & public health, regional transportation planning & demand forecasting, and bicycle & pedestrian transportation.*

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# DISASTER LAW AND RESILIENCE

**Marsha Baum**

Dickason Professor of Law, School of Law, University of New Mexico, Albuquerque, New Mexico, USA,
*baum@law.unm.edu*

## ABSTRACT

In recognition of the importance of resilience in the face of disasters, the law's response to both natural and human-made disasters must incorporate mitigation and prevention as well as recovery systems. For communities to recover successfully after a disaster, systems must be in place to provide immediate support and to assure disaster risk reduction (DRR) for the future. The law provides a framework for development of DRR systems, for system monitoring, and for modification of the structure and/or implementation methods to ensure that populations are able to deal with a disaster and to plan for the future.

Legislative and administrative law, both national and international, are important elements in any disaster plan to provide a response that will allow quick recovery and ensure resilience in the face of disasters. This presentation will provide an overview of the legal system and a sampling of the laws that have developed in recent years to respond to disasters. Discussion will include both the United Nations Development Programme's Checklist on Law and Disaster Risk Reduction (2015) and the 2014 Americas Regional Platform on Disaster Risk Reduction.

***BIOGRAPHY**: Marsha L. Baum, J.D., Dickason Professor of Law at UNM School of Law. She received her J.D. from SUNY at Buffalo in 1985 and is a member of the NYS Bar. Her research interests include disaster law, weather and the law, and animals and the law. She is the author of When Nature Strikes: Weather Disasters and the Law.*

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# CHARTER CITIES, INSTITUTIONAL SELECTION, AND GLOBAL RESILIENCE

**MJR Montoya**

Assistant Professor, FITE Department, Anderson School of Management, University of New Mexico, Albuquerque, New Mexico, USA, *mrmonto@unm.edu*

## ABSTRACT

As developing regions throughout the world promote "charter cities" to adapt to the speed of global economic progress, it is increasingly unclear whether the very cities they use to promote their agendas of progress also exacerbate globally connected underground and illicit trade. Eco Atlantic, for example, is being conceived as a global city with special administrative powers similar to China's relationship with Hong Kong and Macau. How do charter cities express the resilience of both states and non-state actors? What role do cities play in shaping the world economy? Recent literature on "charter cities" suggests that cities reveal the tension between cities (which mediate rapid economic changes) and nations (which try to slow growth in order to maintain a coherent political identity). While charter cities are a way for national systems to develop transnationally in ways that are not necessarily facilitated (or in some cases permitted) by conventional nation-based practices, they also reinforce global problems such as illicit drug trade and human trafficking which develop concurrently with massive urban growth.

This research reviews the literature on "institutional selection" to distinguish the economic function that cities play relative to their respective national systems. I propose that parallel economy can be understood as a significant by-product of the disjuncture within the city/nation complex and that charter cities are an entry point to measuring the world economy. I will perform a basic institutional analysis of "charter cities" (i.e. Eco Atlantic/Nigeria, Hong Kong/China, Trujillo/Honduras) to determine if and how they relate to the vulnerability of national political identities. These descriptions will also measure parallel economies and by extension uncharted dimensions of the world economy. This work will conclude by posing several specific examples of global problems that emerge when charter cities develop, including issues of international trade and sovereign currency.

***BIOGRAPHY**: MJR Montoya, PhD, is an Assistant Professor of Global Structures and International Management at the University of New Mexico, Anderson School of Management. He is a member of the Council on Foreign Relations and is Endowed Chair of Creative Enterprise. His research interests include global political economy, critical theory, and institutional economics.*

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# THE ECONOMICS OF WATER AND FIRE: AN OPTIMAL CONTROL PERSPECTIVE

**Jingjing Wang**

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Albuquerque, New Mexico, USA, *wangj@unm.edu*

## ABSTRACT

Climate changes pose challenges for the already parched Southwest region that is expected to get warmer and drier. Severe and sustained drought will stress the region's scarce water sources; more wildfire and increased risks to communities across extensive areas are projected. In this presentation, we apply the optimal control framework to explore adaptive strategies for managing groundwater and wildfire in the region, especially under changing climate conditions.

Intensive extraction of groundwater in many regions has resulted in a decline in freshwater reserves and reduces local water supply. Climate change is likely to intensify the problem in the future through multiple mechanisms. For the Southwest, in areas where mean annual rainfall will decrease but the frequency of storms will increase, runoff to the surface water will rise and groundwater recharge into aquifers will fall. We develop a dynamic model (where the effects of current decisions on future benefits are taken into consideration) to examine the optimal intertemporal rate of groundwater extraction with adaptation to the impacts of climate change (e.g., invest in recharge infrastructure to enhance groundwater replenishment). Numerical simulations are conducted to compare optimal extraction and investment paths as well as the net benefits associated with groundwater use under different scenarios of climate change. The same approach is applied to wildfire management. Economic theory has long played an important role in establishing wildfire management budgets in the United States. This role has increased in significance over the last four decades in response to consistently rising expenditures to prevent, control, and suppress wildfire, especially in the Southwest. We develop a comprehensive and dynamic framework for wildfire economics. The framework will be applied to ponderosa pine forests in the Southwest to evaluate the present value of net benefits associated with wildfire management and forest restoration, including potential benefits of carbon balance.

***BIOGRAPHY**: Jingjing Wang, PhD, Assistant Professor of Economics and Senior Fellow of the Robert Wood Johnson Foundation Center for Health Policy at UNM. She received her Ph.D. from the University of California at Riverside in 2012. Her areas of research include environmental and natural resource economics, with an emphasis on water resource management, pollution control, bioenergy, and ecosystem services valuation.*

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# THE GLOBAL RESILIENCE MOVEMENT: BOUNCING BACK FROM THE SHOCKS AND STRESSES OF THE 21ST CENTURY

**Charles Rath**

President & CEO, Resilient Solutions 21, Albuquerque, New Mexico
*charles@resilientsolutions21.com*

## ABSTRACT

During this presentation, we will explore the challenges facing modern day societies. We will examine different types of shocks and stressors and explore innovative, multi-dimensional ways to address them. Finally, Charles and RS21 Visual Informatics Lead, recent UNM graduate student, Kameron Baumgardner, will demonstrate RS21's recent work for the Rockefeller Foundation's 100 Resilient Cities Challenge and the US government.

***BIOGRAPHY**: Charles Rath is the President & CEO of Resilient Solutions 21 (RS21), a global consultancy created to help communities, cities, systems and businesses flourish in today's world. RS21 designs imaginative solutions to help customers prepare for disasters and solve chronic issues affecting their capacity to adapt to changing conditions. The company's current portfolio of work includes innovative resilience projects with USAID, DHS, NGOs and cities across the world. RS21 is a Platform Partner for the global 100 Resilient Cities Challenge.*

*Before starting RS21, Charles led the Resilient Cities Program at Sandia National Laboratories (SNL), a program developed to support cities across the world in their efforts to overcome the shocks and stresses of the 21st century. Under Charles' direction, the program coordinated a diverse portfolio of 10 robust capabilities tailored to enhance the resilience of cities, systems, communities and individuals. He built partnerships with strategic collaborators and orchestrated close ties with the Rockefeller Foundation, Swiss Re, United Nations, USAID, Microsoft, US Congress, and several US federal agencies.*

*Charles was identified as a 40 under 40 Vanguard by Next City in 2015. He speaks globally on issues related to resilience, with a particular focus on systems thinking and next generation urban analytics.*

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# TOPOLOGICAL SURVIVABILITY OF NETWORKS FOR RESILIENCE ANALYSIS OF CRITICAL INFRASTRUCTURE

**Svetlana V. Poroseva**

Assistant Professor, Department of Mechanical Engineering, University of New Mexico, Albuquerque, New Mexico, USA, *poroseva@unm.edu*

## ABSTRACT

In our research, networks of interest are those with sources and sinks. Many engineering systems including all critical infrastructures fall in this category. The system topology or *interconnectivity of the system elements* is at the core of resilience of any system, but their relation is not well understood and described. A goal of our study is to quantify this relation.

Various factors contribute in the system resilience. Of particular interest for the current study is the system survivability, which is due to the system topology or *topological survivability*. The system survivability is defined as its ability to withstand multiple simultaneous faults. A number of faults and their locations within a system are assumed to be unpredictable. Such faults are typically caused by adverse events and are not covered by standard reliability/availability analyses of systems under normal operational conditions. Faults may also accumulate with time without repair or result from a combination of predictable and unpredictable factors.

A probabilistic framework for a quantitative analysis of the topological network survivability will be presented. The approach is a unique rigorous procedure not limited by the faults cause, evolution, and interaction. Thus, it is applicable to a wide spectrum of problems. Computational challenges of the approach will be discussed. “Selfish” algorithm for reducing the computational cost of the survivability analysis will be introduced. As an example, application to power systems will be considered.

***BIOGRAPHY**: Svetlana V. Poroseva, PhD, Assistant Professor at the UNM Department of Mechanical Engineering. She received her Ph.D. from the Novosibirsk State University, Russia in 1996. Her research interests include network survivability, CFD, renewable energy, and uncertainty analysis.*


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# BIG DATA: BRIDGING SCALABILITY AND RESILIENCY FOR ANALYTICS

**Trilce Estrada**

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Albuquerque, New Mexico, USA, *trilce@unm.edu*

## ABSTRACT

Advances in science and technology over the past decade led to an explosion of data across all scientific disciplines. As more data is generated and collected in physically distributed locations, data movement and centralized analysis are turning into bottlenecks that hinder the full potential of manipulating Big Data. These challenges are more evident in fields like genomics, astronomy, and medicine where data is so large it cannot be stored in a single physical location, or where data collection is not only expensive but also sensitive to privacy issues preventing data to be shared across different sites. Thus, learning from such datasets has to be done in a distributed and resilient way. My research bridges the need of collecting and managing distributed data with the need to enable scalable, resilient, distributed data analysis. We provide a comprehensive approach to handle data-to-knowledge extraction, representation, and learning at scale when data sources are not only distributed but also potentially unreliable.

In this talk, I will present a brief introduction to Big Data challenges and methods. Then I will present a case study on how Big Data can be used to increase resiliency of scientific discovery in the presence of uncertainty, particularly in the context of a high-throughput protein-ligand docking application. Finally, I will present a broader vision of how Big Data technologies can be applied to a broader set of resilience problems.

***BIOGRAPHY**: Trilce Estrada is an Assistant Professor in the Department of Computer Science at the University of New Mexico. She earned her PhD in 2012 from University of Delaware. Her research interests include real-time decision-making for high-throughput multi-scale applications, scalable analysis of distributed datasets, and interdisciplinary computer science.*

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# CYBER-PHYSICAL SYSTEMS FOR RESILIENT INFRASTRUCTURE

**Meeko Oishi**

Associate Professor and Regents' Lecturer, Department of Electrical and Computer Engineering, University of New Mexico,
Albuquerque, New Mexico, USA, *oishi@unm.edu*

## ABSTRACT

Cyber-physical systems are often marked by complexity that creates both theoretical and computational challenges for methodological design, implementation, and control. The integration. As computing power continues to grow and embedded automation becomes commonplace, advanced tools and methods are needed to analyze and control cyber-physical systems, especially when human interaction is required. In system such as critical infrastructure, in which safety is paramount, assurances beyond those available through extensive simulation are necessary.

We model cyberphysical systems as hybrid systems, in which continuous dynamics arise from the laws of physics, and discrete dynamics arise from the automation's mode-logic. We consider resilience to be a property of the state of the system, and construct those initial states from which resilience is assured, despite uncertainty and external disturbance processes. We have developed methods, based in stochastic reachability analysis, to compute probabilistic safety or reachability, that is, a likelihood of remaining within a constraint set or reaching a known target, possibly under incomplete information (that is, inaccurate or incomplete observations as well as noise-corrupted dynamical processes). We consider a simple formulation in which resilience is the likelihood of recovery from failure, and evaluate our method on several simple dynamical models. We can also consider alternative formulations of resilience that incorporate robustness (e.g., a lack of sensitivity) to disturbance effects and incomplete information.

***BIOGRAPHY**: Meeko Oishi is an Associate Professor in Electrical and Computer Engineering at the University of New Mexico. She received the Ph.D. from Stanford University in 2004, MSc from Stanford University in 2000, and BSE from Princeton University in 1998. Her research interests include cyber-physical systems and control, hybrid control theory, human-in-the-loop systems, and motor control in Parkinson's disease.*

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# PROBABILISTIC CHARACTERIZATION OF CASCADING FAILURES IN ELECTRIC-CYBER INFRASTRUCTURE

**Majeed M. Hayat**

Professor, Department of Electrical and Computer Engineering, University of New Mexico, Albuquerque, New Mexico, USA, *hayat@unm.edu*

## ABSTRACT

Modern power infrastructures, including smart grids, comprise of three interacting and inter-dependent networks: a power grid, a control/communication network, and a network of human agents and operators managing or utilizing the power grid. Large cascading failures in transmission grids can be triggered by a combination of initial failures and lack of proper corrective actions. Initial disturbances can be due to natural disasters, human faults or coordinated malicious attacks. In the past decade, researchers at UNM have launched a multidisciplinary effort to develop a framework for the probabilistic modeling of the behavior of cascading failures in coupled/interdependent power grids, SCADA, and communication networks. This setup also models the stochastic dynamics of human-factors associated with grid operators. Both analytical models, based upon our novel concept of interdependent Markov chains, as well as simulation-based strategies, which are based upon coupled power and communication network simulator tools, have been developed. What is unique about this work as compared to other methods (based, for example, on percolation or random-graph theory) is that it can describe cascading behavior in power systems in terms of physical, non-abstract system attributes such as load controllability (e.g., ability to implement load shedding), inaccuracy or uncertainty in the information available on the grid via the SCADA system, the ratio of the total load to total generation capacity, as well as probability of making diagnostic and corrective decisions by grid operators. The framework also allows us to specify the structure and strength of the interdependencies amongst the transmission and communication networks, and the chain of stochastic state transitions in human-operator behavior. Of specific interest is the role of system interdependencies on the critical probabilistic behaviour of cascading failures and blackout size.

***BIOGRAPHY**: Majeed M. Hayat is a Professor of UNM's Electrical and Computer Engineering. He received his Ph.D. from the University of Wisconsin-Madison in 1992. His research interests include interdependent networks with applications to cyber-physical infrastructures, analytics for distributed computing, signal and image processing, and optical communication. He is a Fellow of IEEE, OSA and SPIE.*

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# RESILIENCE-BASED ASSESSMENT OF WILDFIRE IMPACTS ON BUILT AND NATURAL CIVIL INFRASTRUCTURE

**Vanessa Valentin**

Assistant Professor, Department of Civil Engineering, University of New Mexico, Albuquerque, New Mexico, USA, *vv@unm.edu*

## ABSTRACT

Civil Infrastructure is at risk of experiencing wildfire-related damage, whether directly from fire heat or more frequently, from secondary hazards such as subsequent flash flooding resulting from wildfire-induced changes to the watershed. Post-fire flood events have unique characteristics that threatens natural and engineered infrastructure including the transport of high loads of sediment and debris flow. The understanding of these impacts can help providing better protection, maintenance and upgrade to infrastructure components at risk of wildfire.

In this presentation, resilience is discussed as a metric for quantifying wildfire impacts. Methods for modelling pre and post fire conditions are discussed. An overview about integrated frameworks for evaluating wildfire risk mitigation and response alternatives considering infrastructure is provided. Challenges in this line of research are also summarized.

***BIOGRAPHY**: Vanessa Valentin, PhD, Assistant Professor, University of New Mexico, Civil Engineering. She received her Ph.D. from Purdue University, West Lafayette, IN in 2011. Her research interests include risk management, decision-making, simulation and analytical modelling.*

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# IMPROVING INFRASTRUCTURE RESILIENCE ASSESSMENT USING STRUCTURAL HEALTH MONITORING DATA

**Mahmoud Reda Taha**

Professor and Chair, Department of Civil Engineering, University of New Mexico, Albuquerque, New Mexico, USA, *mrtaha@unm.edu*

## ABSTRACT

In spite of the significant advancement in structural health monitoring (SHM) of civil infrastructure, assessment of structural resilience post natural hazards remains challenging. Realizing methods for evaluating infrastructure network resilience is of utmost importance when considering mega size infrastructure development projects such as those planned in the Suez Canal region in Egypt. The challenge in evaluating system resilience stems from its many definitions and the need to incorporate quantitative and qualitative measures for realistic evaluation of system recovery.

Here, we define infrastructure resilience as the ability of the infrastructure system to absorb and recover from adverse events (e.g. earthquake, flood, and hurricane). Realization of infrastructure behaviour requires a robust SHM system that provides information prior to and after the adverse event. Resilience can be evaluated by considering the direct loss in infrastructure performance and the indirect loss related to post-event restoration. When SHM data is available, direct loss of performance can be evaluated. Precise evaluation of indirect loss is, however, challenging as it incorporates socio-economic and environmental losses associated with infrastructure service disruption.

In this presentation, we present a method to evaluate infrastructure direct loss based on SHM observations. The proposed method is based on classifying structural damage using SHM data and using this uncertain classification to quantify direct performance loss using structural fragility curves. The loss function can then be used to calculate system resilience as a performance metric. A case study is presented on 185 m cable stayed bridge subjected to foundation scour during a flood event. We suggest that the proposed method can be used to design robust SHM systems to provide necessary information to evaluate infrastructure resilience.

***BIOGRAPHY**: Mahmoud Reda Taha, PhD, PEng, Professor & Chair of UNM Civil Engineering. He is also the founding director of UNM Resilience Institute. He received his Ph.D. from the University of Calgary, Canada in 2000. His research interests include structural resilience and health monitoring, nanotechnology and structural composites.*

## NOTES

## NOTES

UNM RESILIENCE INSTITUTE

This colloquium is focused on highlighting research, methods and opportunities necessary for realizing resilient communities and to engage all faculty in UNM, our industry partners and national laboratories involved in the field of resilience and to bring to the core of our discussions contributions from all schools and institutions across campus.

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