Identifying Data Guideline Needs for Community and Regional Resilience Modeling

Center for Risk-Based Community Resilience Planning
National Insitute of Standards and Technology
Federal Emergency Management Agency/Hazus
Simcenter: Computational Modeling and Simulation Center
DesignSafe Cyber Infrastructure
The University of Michigan, Civil and Env. Engineering

Virtual Workshop

Workshop Overview and Objectives: Resilience is the ability to prepare for anticipated hazards, adapt to changing conditions, and withstand and recover rapidly from disruptions. An everincreasing volume of resilience-focused research is being pursued worldwide, ranging from single commercial facilities seeking to maintain continuity of operations to community, regional, and national scales. One commonality regardless of analysis scale is that all modeling endeavours require data, often from a wide range of sources, in a wide range of formats, and across a wide range of disciplines.

This workshop is the first in a short series of two or three workshops that seeks to:

(1) better understand data needs for modeling community and regional resilience across four computational platforms in varying stages of development and use;
(2) outline plans for a common data schema for different stages of analysis and phases of resilience ranging from hazard event to damage/loss of functionality to recovery of physical infrastructure supporting social and economic institutions; and
(3) identify methods to promote data sharing across these four (and other) platforms.

This workshop seeks broad user community input to (1) and (2). A four-page extended abstract of each computational platform and their data structure will be made available to participants prior to the workshop and posted on the workshop website.

AGENDA **Friday, March 19, 2021; 9:00AM-3:00PM MDT (11:00AM-5:00PM EDT)** **Join Zoom Meeting**	
9:00 – 9:30AM	**Welcome and workshop format & objectives** *John W. van de Lindt & Therese P. McAllister*
9:30 – 11:10AM	**Resilience computational platform overviews: models, scales, hazards, damage, recovery, and data** 20 minute presentations with 5 min Q&A after each
9:30-9:55AM	HAZUS – FEMA's Loss Estimation Toolkit for Floods, Hurricanes, Earthquakes, and Tsunamis *Jordan Burns and Doug Bausch, NiyamIT Inc./HAZUS*
9:55-10:20AM	SimCenter Computational Modeling and Simulation Center

	Frank McKenna and Adam Zsarnoczay, NHERI SimCenter
10:20-10:45AM	SRTI: Simple Run Time Infrastructure *Sherif El-Tawil, University of Michigan*
10:45-11:10	IN-CORE: The Interdependent Networked Community Resilience Modeling Environment *John W. van de Lindt and Jong Sung Lee, Center for Risk-Based Community Resilience Planning*
11:10 – 11:30	DesignSafeCI: Data Publishing and Computational Resources *Laura Lowes, DesignSafe CI*
11:30AM – 12:00PM	**BREAK** **Questions gathered via Chat field for panel discussion on computational platforms**
12:00 – 12:45PM	**Panelists responding to questions on the four platforms and DesignSafe CI (All presenters)** *Moderator: Therese P. McAllister* *Chat Moderator: Shane Crawford*
12:45 –1:00PM	**Breakout room instructions** *John W. van de Lindt*
1:00 –1:45PM	**Breakouts** **Room 1: Community and regional models** *Facilitator: Sherif El-Tawil* *Panelists: Hiba Baroud, Gian Paolo Cimellaro, Harvey Cutler, Tracy Kijewski-Correa, Ali Mostafavi, Walt Peacock* Community- and regional-scale simulations include geographically distributed buildings, infrastructure networks, social institutions, demographics, and economics. The data types and models used in these simulations are therefore quite diverse in structure, format and type, and rooted in disparate disciplines, including engineering, social science, medicine, emergency management and economics. Massive amounts of data are needed to fully characterize a community, its residents and its asset inventory. The need to characterize multi-disciplinary community and regional models raises the following key questions: • What types of data are needed but difficult to find? Easy to find but difficult to use? • How can automated collection techniques, e.g., that use machine learning, machine vision, or crowdsourcing, be deployed to collect and characterize high quality data? • How can multi-scale data with spatial and temporal variations be integrated to achieve an accurate and coherent description? • How can interdependencies be characterized? **Room 2: Damage prediction** *Facilitator: Laura Lowes* *Panelists: Doug Bausch, Henry V. Burton, Stephanie Paal, Jean-Paul Pinelli, David Prevatt, Anne Wein* Here damage prediction includes prediction of damage sustained by physical infrastructure and the resulting loss of functionality as well as damage sustained by social institutions. Damage prediction is complicated by interdependencies between systems. Damage data are diverse in structure, format and type and require the following considerations: • How do you efficiently collect and characterize data on: o Damage characteristics that indicate damage states for various infrastructure components, with damage states corresponding to repair or replacement as well as various levels of reduced functionality? o The effect of reduced component functionality on overall network performance?

- Injuries, economic impacts and social effects and the interdependencies between them in the aftermath of severe events?

- How can automated collection techniques, e.g., that use machine learning, machine vision, or crowdsourcing, be deployed to collect and characterize high quality data after a hazard event has occurred?
  - Damage effects are not necessarily sequential and rarely fall into neat phases. How can evolving interdependencies be modeled, e.g. interaction between recovery operations and subsequent shocks or varying system demands during recovery?

  How can property owners right to privacy be maintained if automated data collection methods are used? How can damage, loss of functionality, and recovery be simulated if privacy concerns limit availability of data?

Room 3: Recovery models

Facilitator: Therese P. McAllister
Panelists: Louise Comfort, Bradley Ewing, Seth Guikema, Leonardo Dueñas-Osorio, Yu Xiao
Chat Moderator: Shane Crawford

Recovery following a hazard event is not only a function of damage and loss of functionality, but depends on socio-economic variables for households and businesses such as race/ethnicity, household income, educational level, and local governanace structure. While such data are often available through the U.S. Census (other sources depending on country), they are aggregated to provide privacy to individuals and thus data are available at scales that differ substantially from those characterizing damage to infrastructure components. Data-driven models are often used for modeling impacts to social institutions and demographic changes whereas physics-based models are often used for infrastructure systems. To better understand data needs for recovery models the following should be considered:

- How does the spatial and temporal scale of input data and model results affect other models (e.g., physical model output as an input to data driven models to link physical damage to social impacts)?
- Recovery trajectories are often used to model physical systems, but recovery takes years. What data are needed for these models? How can they be validated?
- How can economics models and the place-specific data needed to run them be generalized enough for broad use in recovery modeling?
- What type of data are needed to assess the effects of interdependencies between recovering lifeline systems. How do you take into account the effects of constrained resources during the recovery phase?

Room 4: Mitigation models

Facilitator: Jordan Burns
Panelists: Paolo Bocchini, Rachel Davidson, Tucker Mahoney, Jesse Rozelle, Adam Zsarnoczay

Mitigation can improve the performance of existing infrastructure and reduce the level of damage for hazard events. Effective mitigation is essential for community and regional resilience and depends on (1) characterization of existing infrastructure and supported social and economic functions and (2) goals for performance and recovery for hazard events. However, not all structures should be mitigated, as mitigation options may not be cost effective for many structures.

- What data and analyses can help inform the effectiveness of mitigation options being considered? What role does socio-demographic data play?
- What data are needed to extend mitigation modeling to include damage and recovery modeling?
- What level of uncertainty is acceptable for modeling the cost-effectiveness of mitigation strategies at scales larger than a single structure, in order to draft broader policies?

	Room 5: Policy models *Facilitator: John W. van de Lindt* *Panelists: Steven French, Sara Hamideh, Jennifer Helgeson, Jay Newman, Rae Zimmerman* The ability to measure the change in the resilience outcome for a community- or regional-scale model through changes in policy represents a unique challenge to modeling and data. It is important to keep in mind that not all policies can be effectively modeled by numerically changing components or states within a model. The implementation of a mitigation strategy is often driven by policy. Mitigation may be a policy being put into action and, if not effective, can then result in a policy change. In this breakout, the following issues are considered: • How hazard dependent are policies? Are there general policies that can be considered for modeling of all hazards? • Which type of policies have available data so that models can measure changes in outcomes for alternative policies? • What are some examples of non-structural policies that can be effectively modeled during the recovery modeling process? • Policies may not be expressed numerically but need to be modeled. What are examples of approaches to quantify policies?
1:50 – 2:50PM	**Panel discussion (Facilitators)** **Q&A/Discussion of questions gathered in the chat during the workshop** *Breakout Chairs: Walt Peacock and Judith Mitrani-Reiser*
2:50 – 3:00PM	**Next steps, timing of workshop report, next workshop announcement, and close** *John W. van de Lindt*