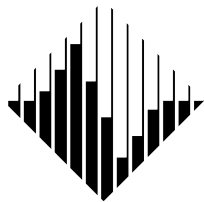


PEER Annual Meeting



PEER

Modeling Community Functioning
Following Earthquakes

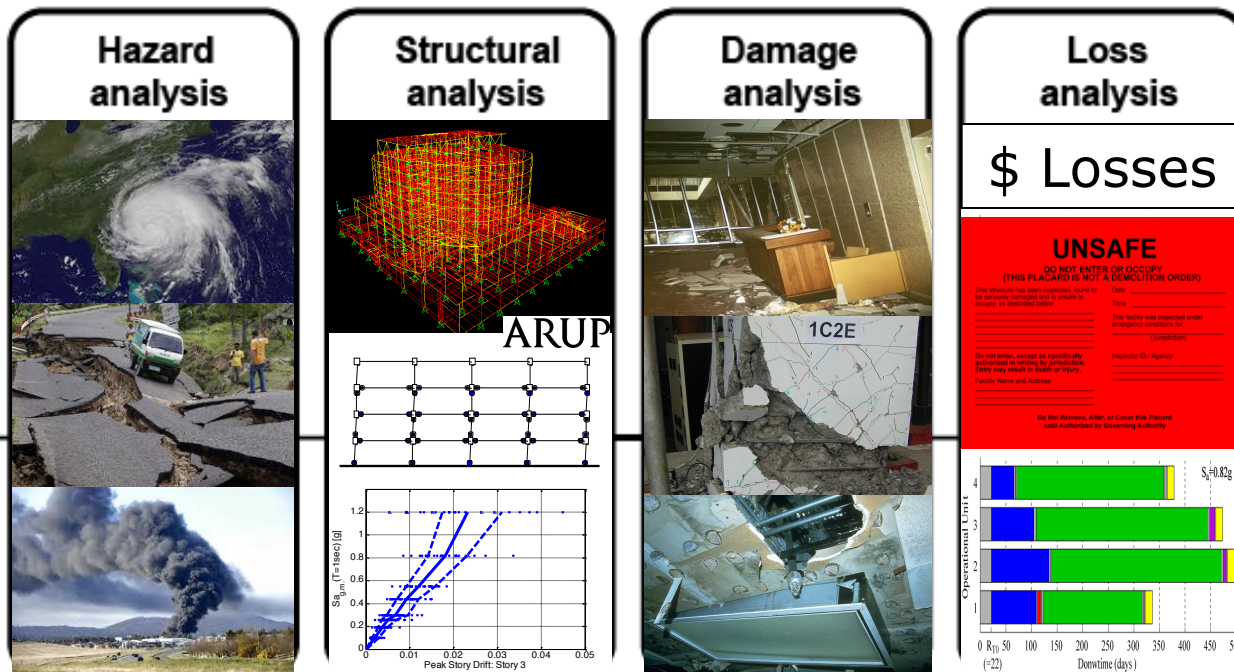
Judith Mitrani-Reiser
Johns Hopkins University

Community Functioning Domains

- Disaster sociologists explain that not all community institutions mitigate disasters, and offer a short list of disaster-relevant institutions (Aguirre et al., 2005):
 - Family
 - Religion
 - Politics
 - Economy
 - Medicine & Health
 - Education
 - Scientific Research
 - Law & Courts
 - Emergency Responders
 - Communication
 - Transportation
 - Energy
 - Food
 - Water
 - Entertainment
 - Construction & Built Environment
 - Land Use

Performance-Based Design: Buildings

PEER PBEE ANALYSIS METHODOLOGY



facility def.
D

D: Location & Design

Performance-Based Design: Downtime in Buildings

- FEMA P-58 downtime procedures provide measures of occupancy interruption:
 - **The length of time necessary to conduct repairs,**
 - **The need to procure items with long lead-times,**
 - **Forcible closure.**



Seismic Performance Assessment of Buildings

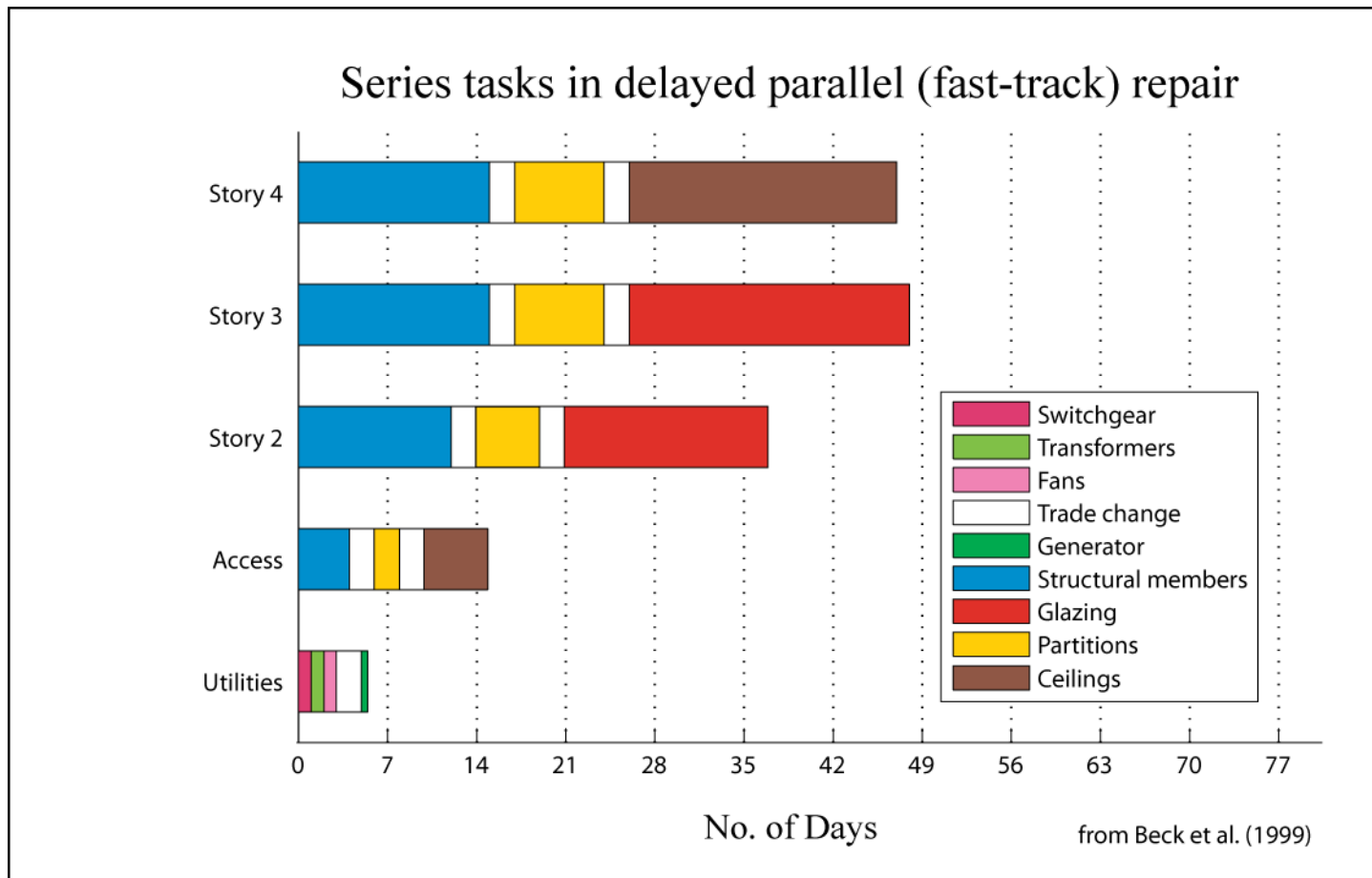
Volume 1 – Methodology

FEMA P-58-1 / September 2012



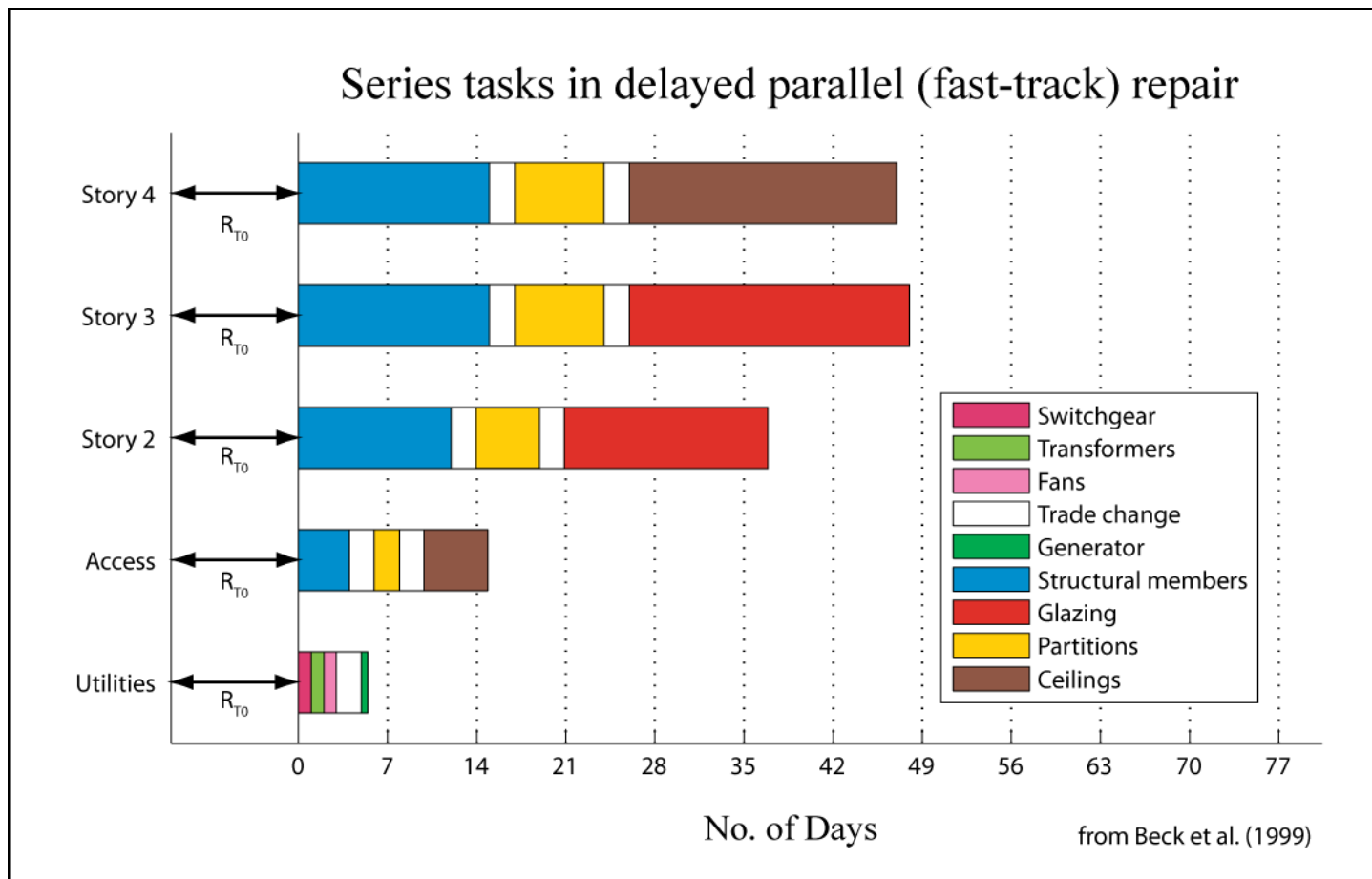
Performance-Based Design: Downtime in Buildings

Repair time is the time needed to repair the earthquake damage and return the building to its pre-earthquake condition.



Performance-Based Design: Downtime in Buildings

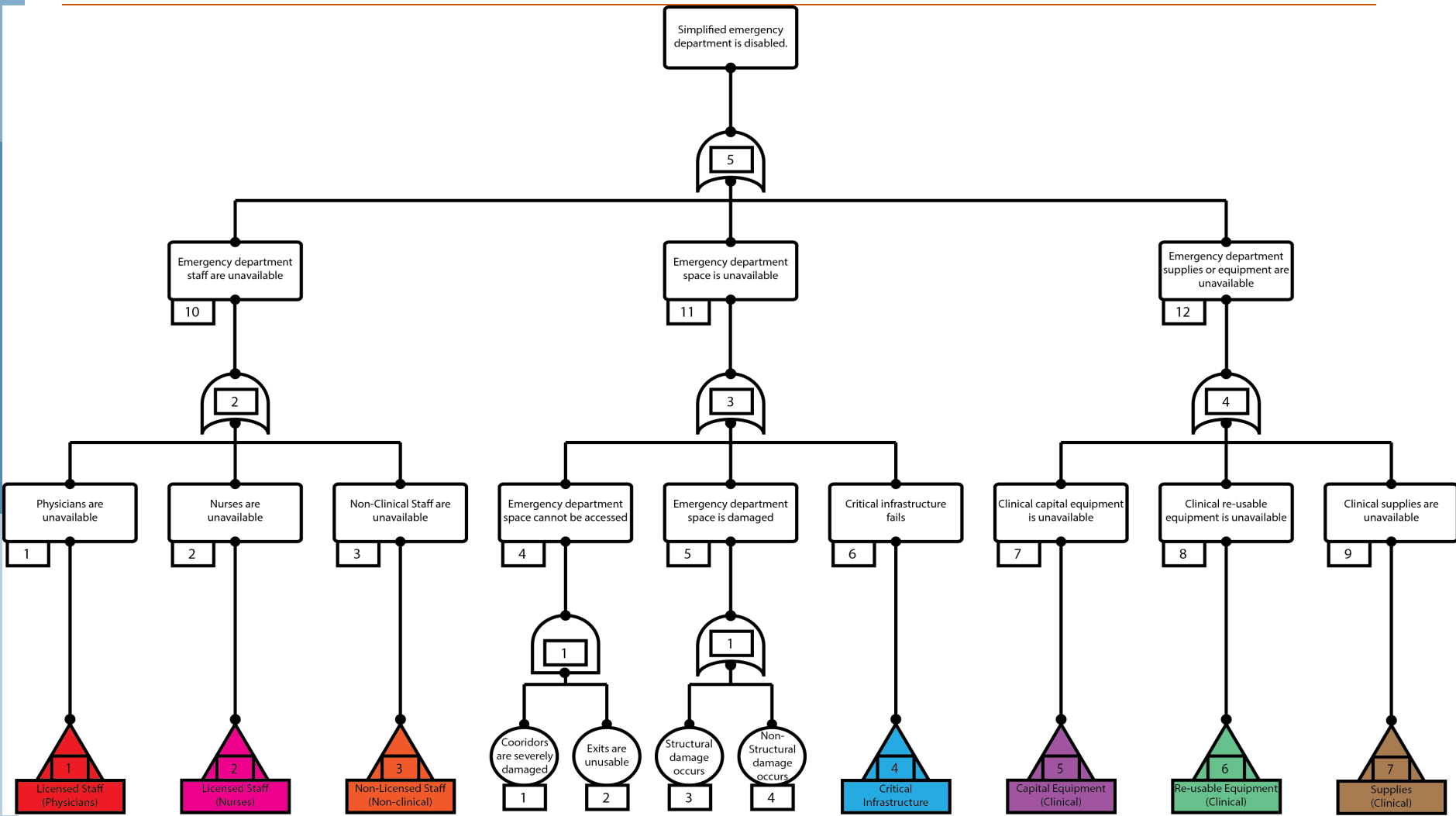
Mobilization Time is the delay before construction begins.



Performance-Based Design: Loss of Function in Buildings

- For very specialized building occupancies (i.e., hospitals), the above procedures will not suffice in capturing the loss of important services:
 - **Need models that include infrastructure failures outside the building.**
 - **Need occupancy-specific models that incorporate human infrastructure.**
 - **Need systematic procedures for capturing building damage and loss of function over time in the field.**

Performance-Based Design: Loss of Function



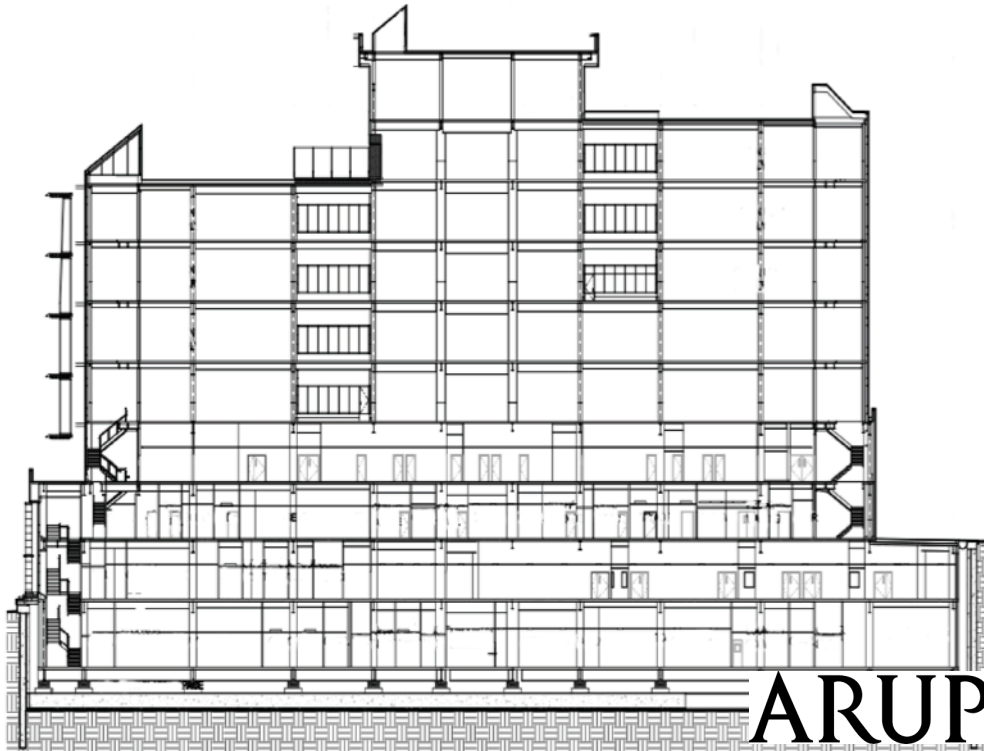
○ **Basic Event:** a failure in a system component and corresponds to data collected in the field study.

□ **Intermediate and Top Events:** The failure (e.g., complete or partial loss of function of a hospital service) that is being assessed and the system states that contribute to the top failure.

∩ **OR Gate:** The output event associated with this gate is true if at least one of the input events exist (e.g., means of egress are impacted if either horizontal or vertical means of egress are severely damaged).

∩ **AND Gate:** The output event associated with this gate is true if all input events exist (e.g., water infrastructure fails when the municipal water and the back-up water systems fail).

Performance-Based Design: Loss of Function



Mechanical Floor

Level 7: Medical/Surgical, Acute Care for Elderly
Palliative Care, Roof Garden

Level 6: Medical/Surgical

Level 5: Medical/Surgical Unit, Forensic Unit

Level 4: Step Down Medical/Surgical,
Step Down ICU, Dialysis

Level 3: Intensive Care Units (ICU)

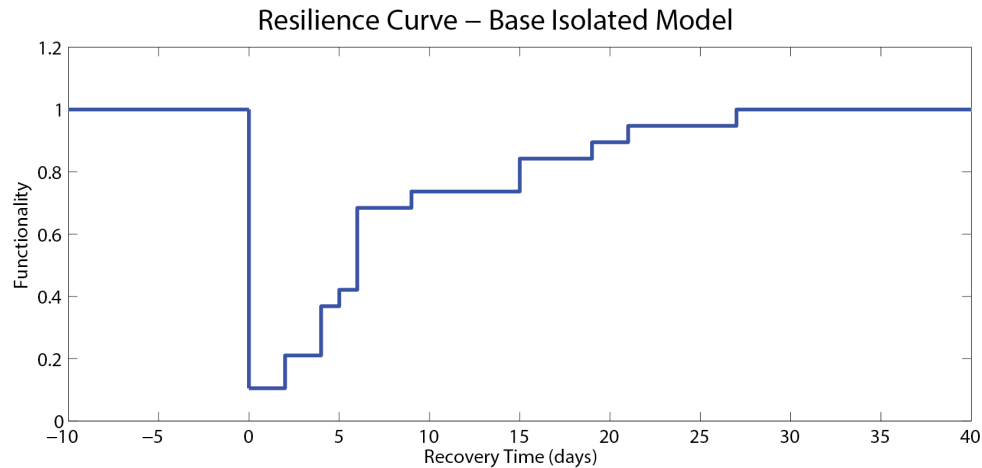
Level 2: Labor and Delivery, Postpartum, Pediatrics,
Neonatal Intensive Care

Level 1: Emergency Department and Trauma Center

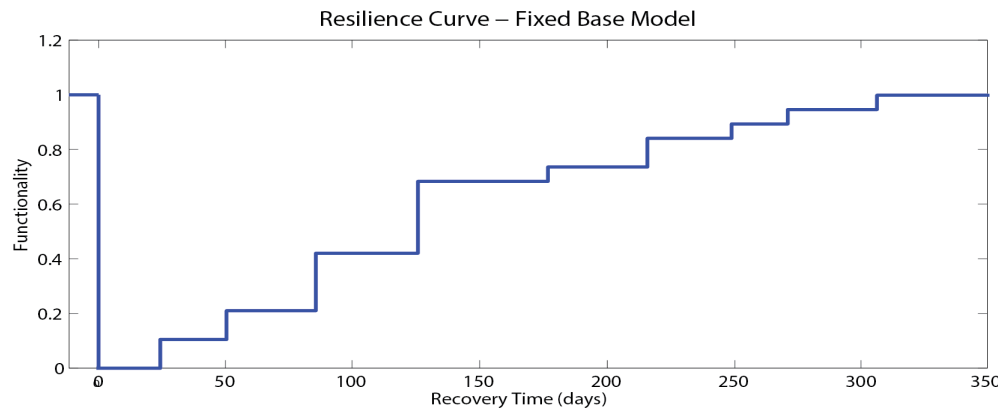
Basement 1: Operating Rooms, Pre-op, Post Op,
Endoscopy, Blood Bank

Basement 2: Dietary, Pharmacy, Cardiology,
Pulmonary, Diagnostic Imaging (Xray),
Sterile Processing

Performance-Based Design: Loss of Function



26 days
until all
hospital
services are
functional



~300 days
until all
hospital
services are
functional

Loss of Functioning of Community Institutions

- The above procedures will not suffice in capturing disaster impacts on important community institutions:
 - **Need models that include interdependent critical lifelines and supply chains.**
 - **Need to capture the 'networked' system of buildings that provides specific community services.**
 - **Need performance metrics that are relevant to the entire system and to the stakeholders managing these institutions.**

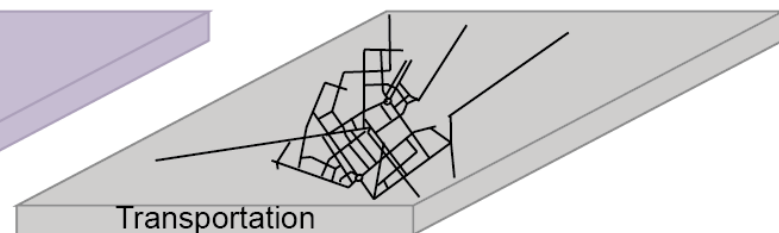
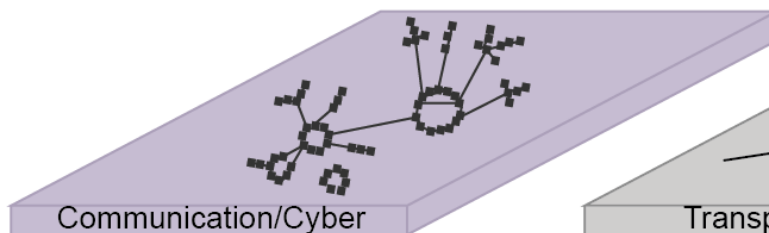
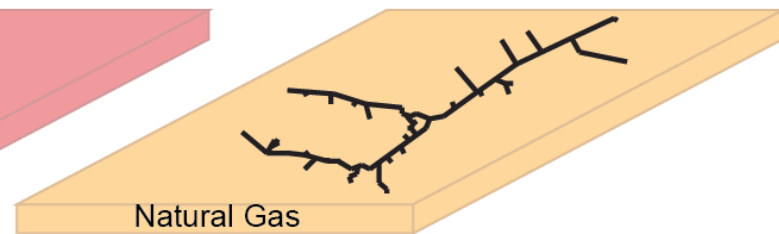
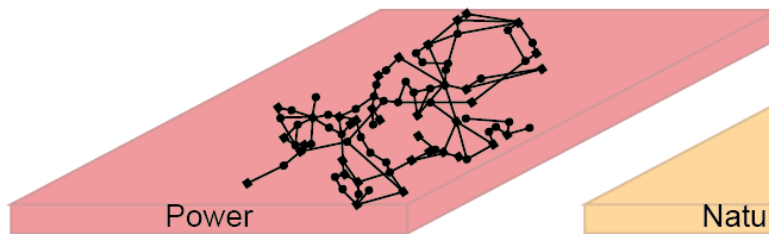
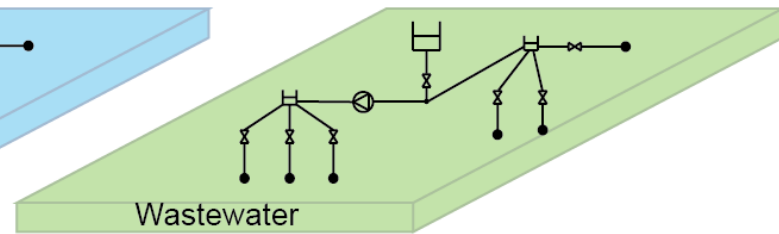
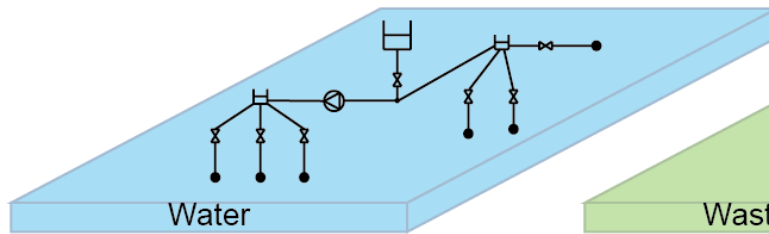
Critical infrastructure-Based Societal Systems (CIbSS)



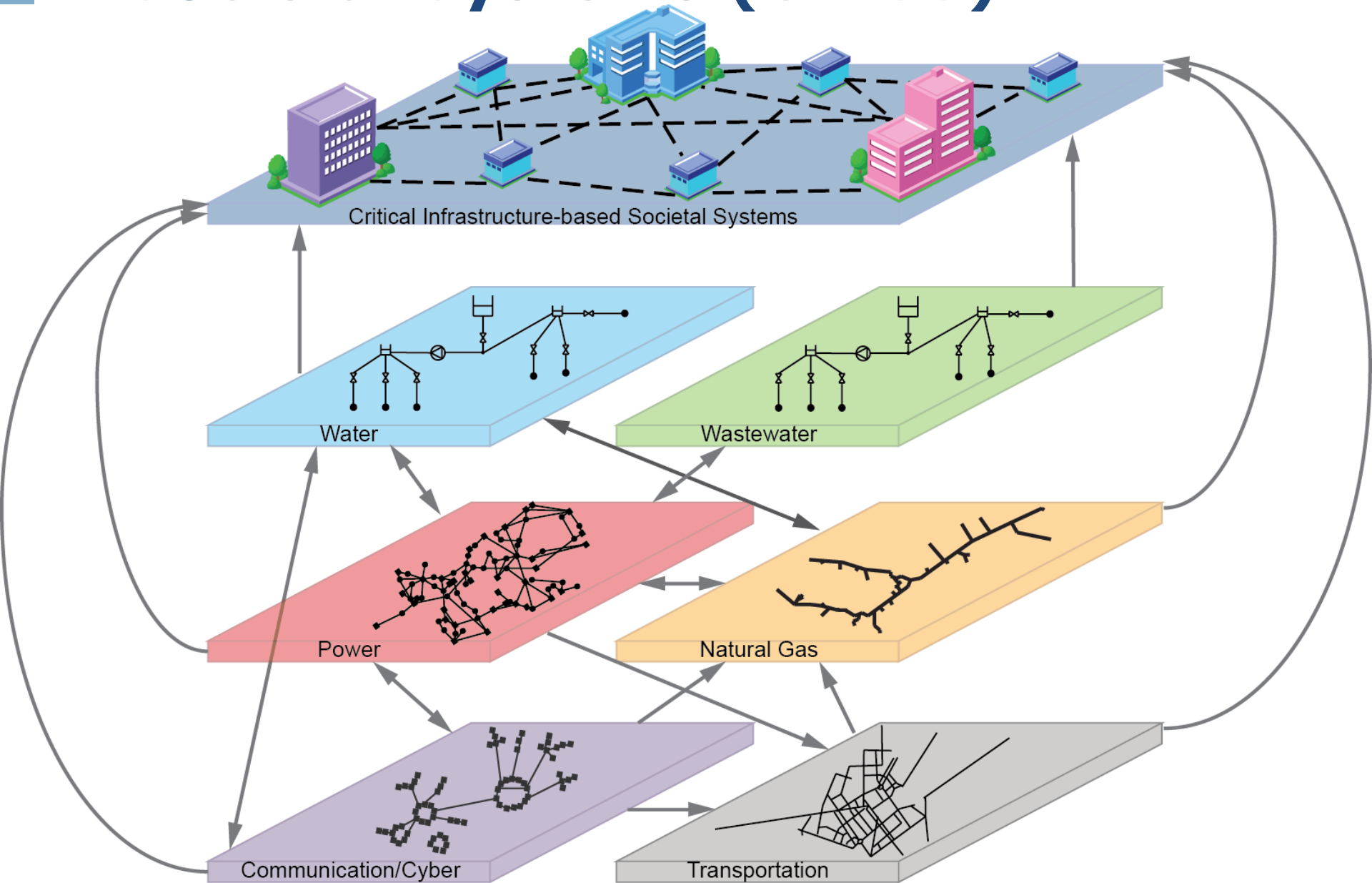
Critical infrastructure-Based Societal Systems (CIbSS)



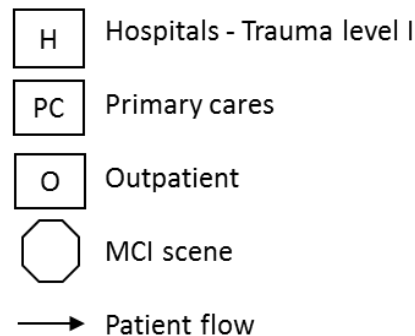
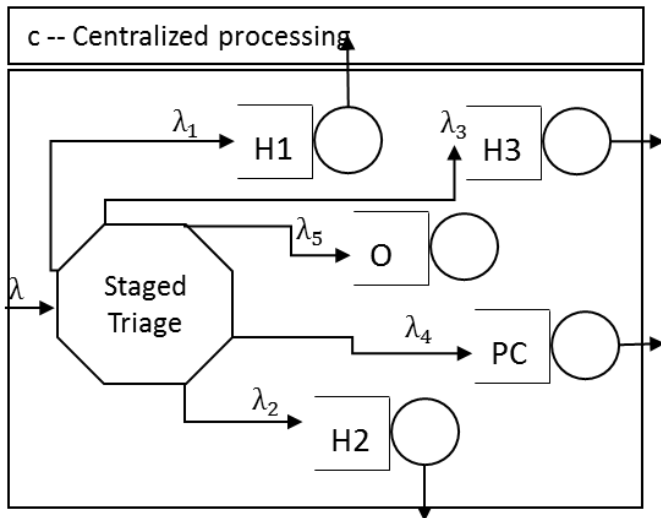
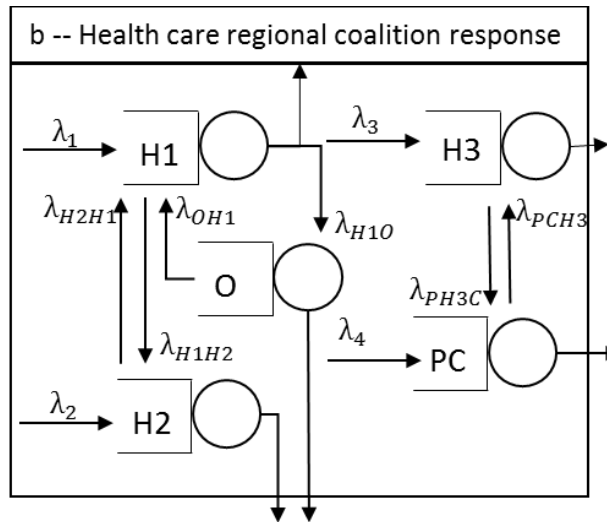
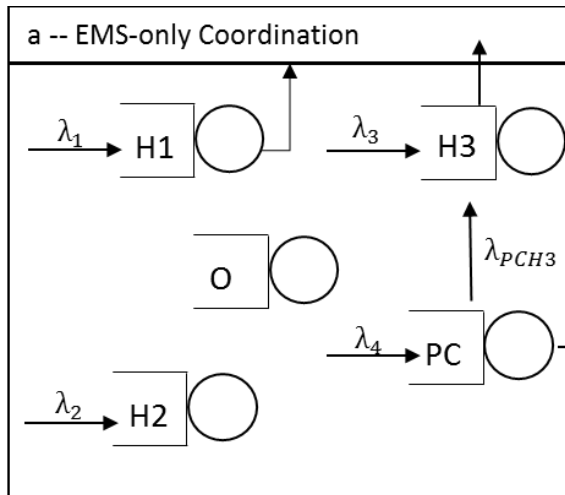
Critical infrastructure-Based Societal Systems (CIbSS)



Critical infrastructure-Based Societal Systems (CIbSS)



Critical infrastructure-Based Societal Systems (CIbSS)



- Discrete event simulation
- Care-paths spanning critical hospital units
- Resource tracking
- Metamodeling with interactions
- Whole health care system coordinated patient flow management



Critical infrastructure-Based Societal Systems (CIbSS)

Population Displacement



Photo: Andrea Booher/FEMA

Economy Security



Photo: Canterbury Earthquake Recovery Authority (CERA)

Food Security



Photo: Shamsuddin Ahmed/IRIN

Healthcare Delivery

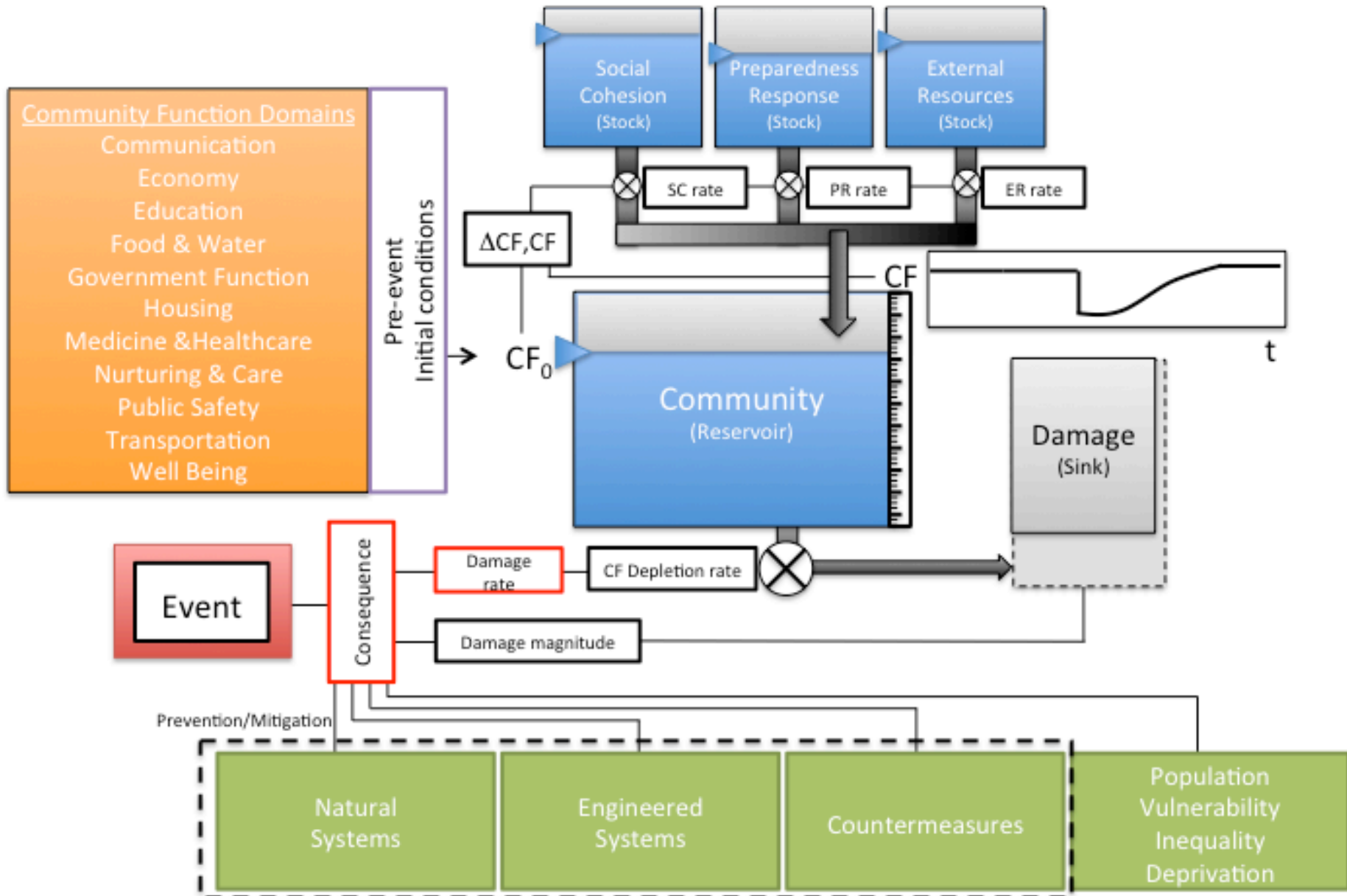


Photo: Judith Mitrani-Reiser/JHU

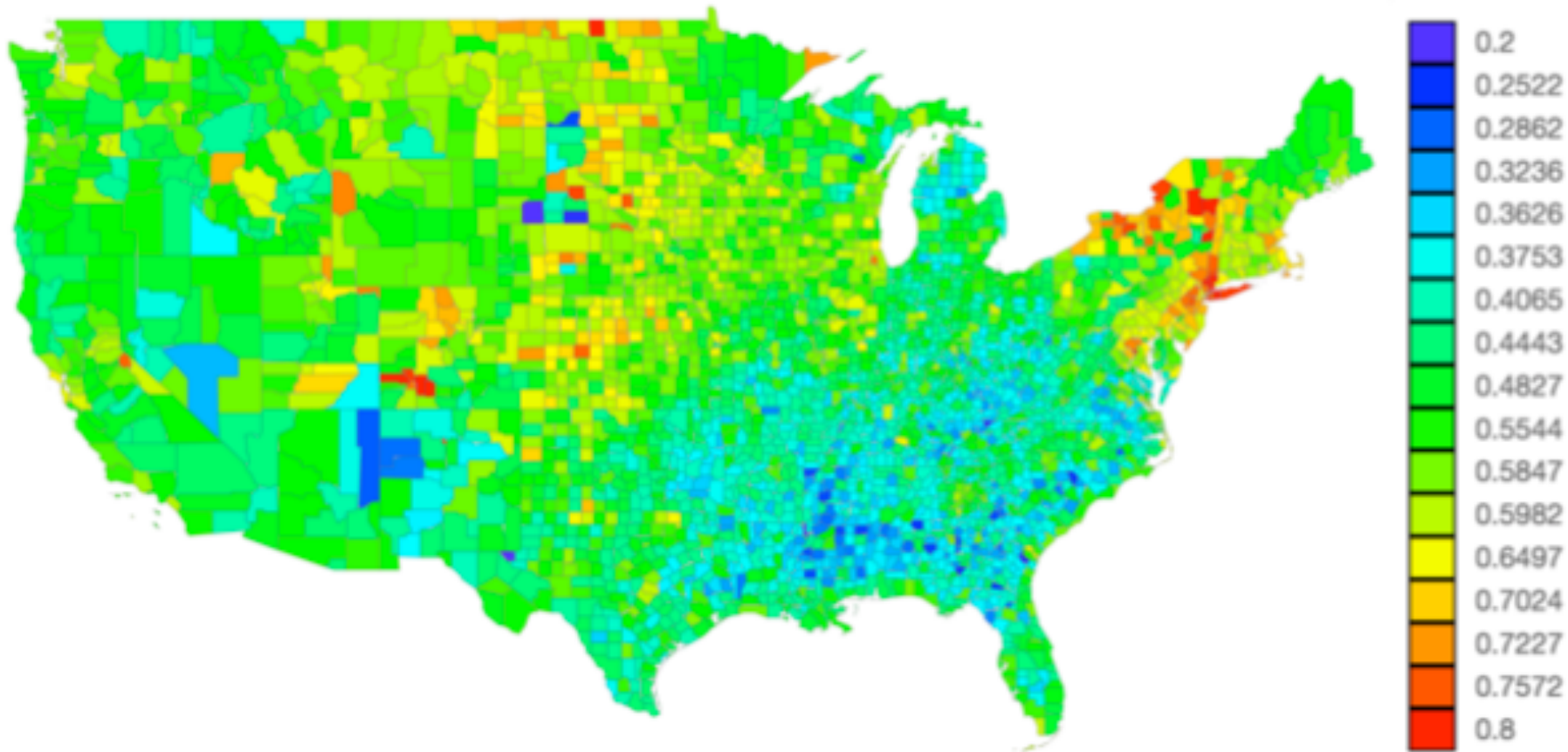
Loss of Community Functioning

- **Need holistic approach to capture community functioning over time.**
- **Need models that interface multiple scales (building – institution – community).**
- **Need to effectively use data that is collected over a wide range of time scales (e.g., census, tax assessors, reconnaissance, etc.).**
- **Need models that capture the complex interactions of many community institutions in response to a disaster.**

Composite of Post-event Well-being (CoPE-WELL)



Composite of Post-event Well-being (CoPE-WELL)



Thank you

