Disaster and Failure Studies Program Updates

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NCST Advisory
Committee Meeting

Jason D. Averill, *Chief*

Materials and Structural Systems Division

NIST

NIST
National Institute of
Standards and Technology
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Recent Disaster Events and NIST Criteria Scores

Decision Criteria and Guidelines

- Provide a rational basis for evaluating the need for an investigation and considers many factors, including:
  - substantial loss of life or disabling injury;
  - significant potential for loss of life (exposed population);
  - level of hazard;
  - consequences to resilience;
  - evacuation/emergency response challenges;
  - applicability of international events (code enforcement; similarity of practices);
  - unique new knowledge that may potentially be gained;
  - potential impact on standards, codes, and practices;
  - safety of field personnel.

Preliminary Reconnaissance Screening Criteria

Date and Event Description			
Preliminary Reconnaissance Criteria	Low (1)	Med (3)	High (5)
1. Substantial Loss of Life or Disabling Injury			
A. Facility context	0	1 to 2	>2
B. Community context	0 to 3	4 to 9	>10
C. Regional context	0 to 5	6 to 19	>20
2. Significant Potential for Substantial Loss of Life: Exposed Population			
A. Facility context	<100	100 to 499	≥500
B. Community context	<1 000	1 000 to 9 999	≥10 000
C. Regional context	<100 000	100 000 to 999 999	≥1 000 000
3. Hazard and/or Failure Event(s)			
A. Earthquake	≤ MMI IV	MMI V to VII	≥MMI VIII
B. Hurricane at Landfall	≤Cat 3	Cat 4	Cat 5
C. Tornado	≤EF3	EF4	EF5
D. Coastal Inundation	< 3 ft	3 to 9 ft	≥ 10 ft
E. Fire Spread in Structures	Fire spread not beyond area of origin	Fire spread throughout a structure	Fire spread beyond structure of origin
F. Wildland Urban Interface Fire (WUI)	High Forest Service Fire Danger Rating	Very High Forest Service Fire Danger Rating	Extreme Forest Service Fire Danger Rating
G. Blast	< 99 lbs. TNT-equivalent	100 - 999 lbs. TNT-equivalent	> 1000 lbs. TNT-equivalent
H. Impact	$< 1 \times 10^6$ ft lb/sec	1×10^6 to 1×10^7 ft lb/sec	$> 1 \times 10^7$ ft lb/sec
4. Consequences to Resilience			
A. Failure during Construction or in Service	Minimal physical damage and/or loss of function	Moderate physical damage and/or loss of function	Severe physical damage and/or loss of function
B. Engineered Building Systems	Minimal physical damage and/or loss of function	Moderate physical damage and/or loss of function	Severe physical damage and/or loss of function
C. Transportation & Utility Systems	Minimal physical damage and/or loss of function	Moderate physical damage and/or loss of function	Severe physical damage and/or loss of function
D. Non-Engineered Building Systems	Minimal physical damage and/or loss of function	Moderate physical damage and/or loss of function	Severe physical damage and/or loss of function
Score: __/__ = __ Sum	__ x 1	__ x 3	__ x 5
5. Evacuation and Emergency Response			
A. Evacuation	Normal evacuation	Moderate evacuation challenges	Severe evacuation challenges
B. Emergency Response	Normal operations	Moderate operational challenges	Severe operational challenges

Application of Decision Criteria for NIST Studies

- Weighted score ≥ 4.0:
  - Above threshold for conducting a preliminary reconnaissance
  - Answers to six general principles questions and summary assessment will be used to determine whether a preliminary reconnaissance will be conducted.
- Weighted score ≤ 3.0:
  - Below threshold for conducting a preliminary reconnaissance.
- 3.0 ≤ Weighted score ≤ 4.0:
  - Answers to the six general principles questions and the summary assessment along with the weighted score will be considered to whether the screening threshold for a preliminary reconnaissance is met.

Recent Disaster Events and NIST Criteria Scores

- Disasters that were evaluated against the criteria since last Advisory Committee meeting (March 2015)

- Calculated preliminary reconnaissance criteria scores

East Village, NYC, Buildings Explosion and Collapse (3/26/2015) – 3.0

- Three 5-story, multi-used (residential/commercial) buildings on 2nd Ave. and 7th St. collapsed and one damaged due to explosion and fire that occurred during illegal tapping of gas line.
- 7-alarm fire. 2 fatalities. 25 injuries, including five FDNY members.
- Surrounding streets were closed and surrounding area evacuated for 3 days due to concern of further collapse, debris.

Louisville, KY, GE Plastics Storage Warehouse Fire (4/03/2015) – 2.0

- Massive four-alarm fire at a 260,000 ft^2 plastics storage warehouse in General Electric appliance Park. Over 200 fire fighters contained the fire to the single warehouse structure.
- No deaths or injuries.
- Leaf-sized pieces of soot or burned insulation were falling as far as three miles away. Residents and building occupants within 0.5 mile radius evacuated.
- Roof of the warehouse collapsed.

Midwest Tornadoes (4/09/15) – 2.8

- Massive tornadoes touched down in Iowa, Illinois and Ohio. These followed at least 8 others that occurred one day before in the region.
- Nearly 100 million Midwest residents were likely affected by the weather pattern spawning these tornadoes.
- One fatality (Fairdale, IL), several injuries, and widespread property damaged, mostly to residential constructions in rural areas

Nepal Gorkha Earthquake (04/25/15) – 2.9

- M_w 7.8, 48 miles NW of Kathmandu, 9.3 miles deep. 728,000 residents exposed to violent shaking (MMI IX)
- 8000 deaths, 21,000 injured. Extensive buildings and infrastructure damage, as well as landslides and avalanches
- Nepal National Building Code (NBC 110) took effects in 1994, but not considered a modern building code and has not been updated regularly or enforced rigorously.

South Carolina Rain-Induced Historic Flooding (10/04/15) – 3.9

- “1,000-year” rain event, related to Hurricane Joaquin, set unprecedented flooding records in many counties of South Carolina
- At least 19 fatalities in South Carolina, 18 dams breached, numerous roads closed including 75-mile stretch of I-95 connecting Miami to Washington, D.C. to New York
- $12 billion damage estimated in South Carolina alone (comparable to Hurricane Hugo in 1989 - $9.5 billion)

Dubai Address Hotel Fire (12/31/2015) – 2.3

- 63-story tower fire at about 9.25pm, triggered by an electrical short circuit on an exterior spotlight between the 14th and 15th floors, took just minutes to spread 40 story up exterior walls.
- Exterior aluminum façade was susceptible to fire and flame spread
- alarms did not sound immediately because the fire started on the outside of the building

Meinong Taiwan Earthquake (02/06/16) – 3.8

- M_w 6.4, 17 miles northeast of Pingtung City, 14 miles deep. MMI VII (*Very strong*).
- 117 deaths (115 in a 17-story collapsed residential building), more than 500 injuries, and widespread damage with 357 buildings collapsed or near collapse (54 mid- and high-rise).
- Structures with damage contained soft/weak story, vertical discontinuity and/or a torsion irregularity.

Kyushu, Japan Earthquakes (April/14 and 15/2016) – 4.5

- Pair of powerful earthquakes, the first, M_w 6.5, struck the Kyushu Island region on April 14, and the second, M_w 7.3, struck the same area on April 15. About 680,000 peoples experienced MMI VIII (*Severe*).
- 44 deaths, > 1000 injured.
- Early report indicated more than 3,000 buildings, mostly low-rise residential but including several multi-story older RC buildings, were damaged. In addition, the earthquakes triggered major landslide, slope failure, bridge collapse, and buckled roadways

Ecuador Earthquake (April/16/2016) – 3.4

- M_w 7.8, epicenter 27km SSE of Muisne, struck coastal Ecuado.
- Death toll at 480, with about 2,560 injuries (as of 4/19/16)
- Widespread damage to buildings (majority unreinforced masonry and concrete buildings) and infrastructure (roads and bridges)
- The 2000 Ecuadorean Code of Construction, translated from UBC-77 Code is rarely enforced.

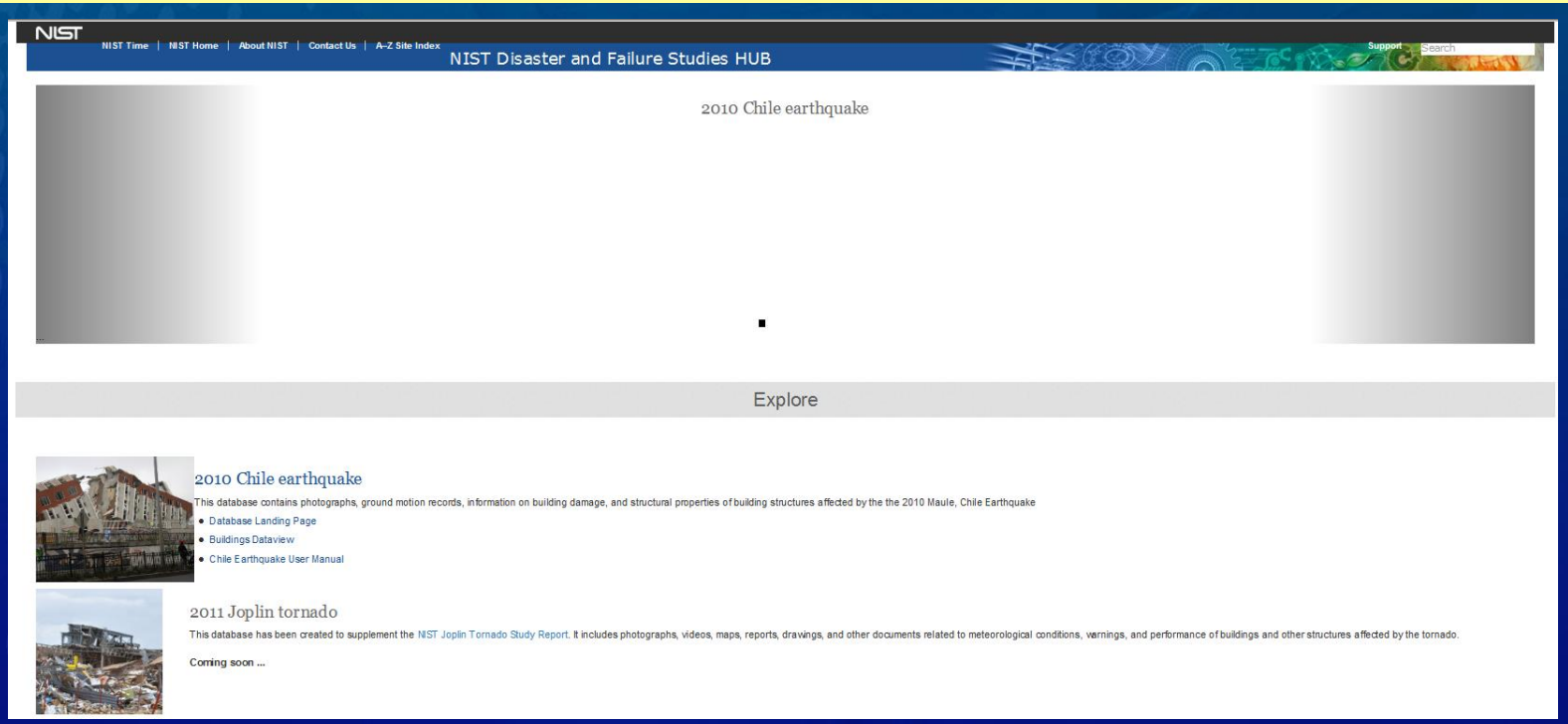
Recent Disasters

Date	Event	Total Weighted Score
3/15	East Village, NYC, Buildings Collapse	3.0
4/15	Louisville, KY, GE Warehouse Fire	2.0
4/15	Midwest Tornadoes	2.8
4/15	Nepal Gorkha Earthquake	2.9
10/15	South Carolina Rain-Induced Flooding	3.9
12/15	Dubai Address Hotel Fire	2.3
02/16	Meinong Taiwan Earthquake	3.8
4/16	Kyushu, Japan Earthquakes	4.3
4/16	Ecuador Earthquake	3.4

Disaster Data Repository Updates

- Chile Earthquake Data Repository – which contains data from the 2010 Maule and the 1985 Valparaiso earthquakes -- now available for public access, at **https://disasterhub.nist.gov/**

- Joplin and Moore Tornadoes Data Repository will be available for public access in Summer 2016.



More information on the Chile Earthquake can be found at: http://www.nist.gov/el/building_materials/chile-quake-at-epicenter-of-expanding-disaster-and-failure-data-repository.cfm

Center for Risk-Based Community Resilience Planning – Thrust 3 Update

Thrust 3: Resilience Data Architecture Validation Studies

Slides Prepared by Todd Clapp and John van de Lindt

- Task 3.1: Intermittent Beta Testing and Algorithm Training
- Task 3.2: Field Study Decision Algorithm
- Task 3.3: Architecture Validation Studies
- Task 4.5: Field Studies in Support of Community Resilience

Task 4.5: Field Studies

Protocol Sections:

1. Introduction and Background
2. Literature Review of Past Field Study Protocols
3. Literature Review of Interdependent Infrastructure
4. General Derivation of Resilience Metric Probability Curves
5. Community Resilience Metrics
6. Field Study Connectivity Flow Chart
7. Data Collection Approach
8. Follow Up Studies: When? Why? and How?
9. Explanation of Data Processing and Data Requirements

IRB Update - CSU

- IRB Completed
- IAA Completed with NIST and several partner universities
- Between 20 to 25 human subject (survey) questions developed and in review by social science team
- Survey questions link physical infrastructure damage with behavior/social science

Review of Past Field Studies

- 13 field study protocols were reviewed; commonalities tracked. Additional reports are currently under review
- Hazards included earthquakes, fire, tornadoes, hurricanes and tsunamis
- Reports were taken from multiple research disciplines:
  - Multi-disciplinary reports (2)
  - Engineering reports (5)
  - Sociology reports (4)
  - Economic reports (2)
- Emphasis was on the data collection methods and strategies, tools, personnel, and decision making processes
- This provides an understanding of the latest methods and tools for multi-disciplinary studies of any natural disaster type

Example From Hurricane Andrew

- Population dislocation data from Hurricane Andrew
  - Residential damage measure
  - Months dislocated
- Dislocation fragilities can be shifted to account for race, gender, income, etc - underway

Community Resilience Metrics

- In order to measure a community's resilience, the NIST CoE will collect practical metrics These metrics are divided into two categories:

1) Metrics that require field study data
    1. Population dislocation: Households displaced
    2. Business interruption: Businesses closed
    3. Employee dislocation: Employees failing to report to work
    4. Critical facilities impact: Critical facilities closed
    5. Housing loss: Units lost

2) Metrics that do not require field study data :
    1. Physical and mental morbidity
    2. Mortality
    3. Fiscal impact: Loss of property tax and sales tax
    - Data for each of these three metrics can be collected from alternative sources

- The community dimensions that are described in NIST GCR 16-001 are embedded into these metrics
    - Dimensions include: sustenance, health, housing and shelter, education and personal development, security and safety, culture and identity, and belonging and relationships

Field Study Connectivity Flow Chart (Partially Shown)

- This flow chart proposes field study questions that can be asked to obtain data on linkages between the physical infrastructure, the social structure and the economic structure of a community
- A formal field study questionnaire has been developed using this flow chart as a reference

Tornado Study Anticipated

- A preliminary small tornado study was carried out for an EF-3 tornado that struck several homes and a water tower.
- Will enable development of water tower fragilities for wind loading
- Team is ready for a larger tornado study and will be collaborating with teams outside of the CoE for efficiency and leverage when possible.

Joplin Community Resilience Hindcast

- Proposal to CoE team underway to utilize Joplin as the first hindcast
  - Logical with NIST data available
  - Tornado loading first addition into NIST-CORE; available now.
- Size reasonable for tractable resilience study at this stage

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Questions?