Disaster & Failure Studies: Scoring of Events & Readiness of Teams

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National Institute of Standards and Technology
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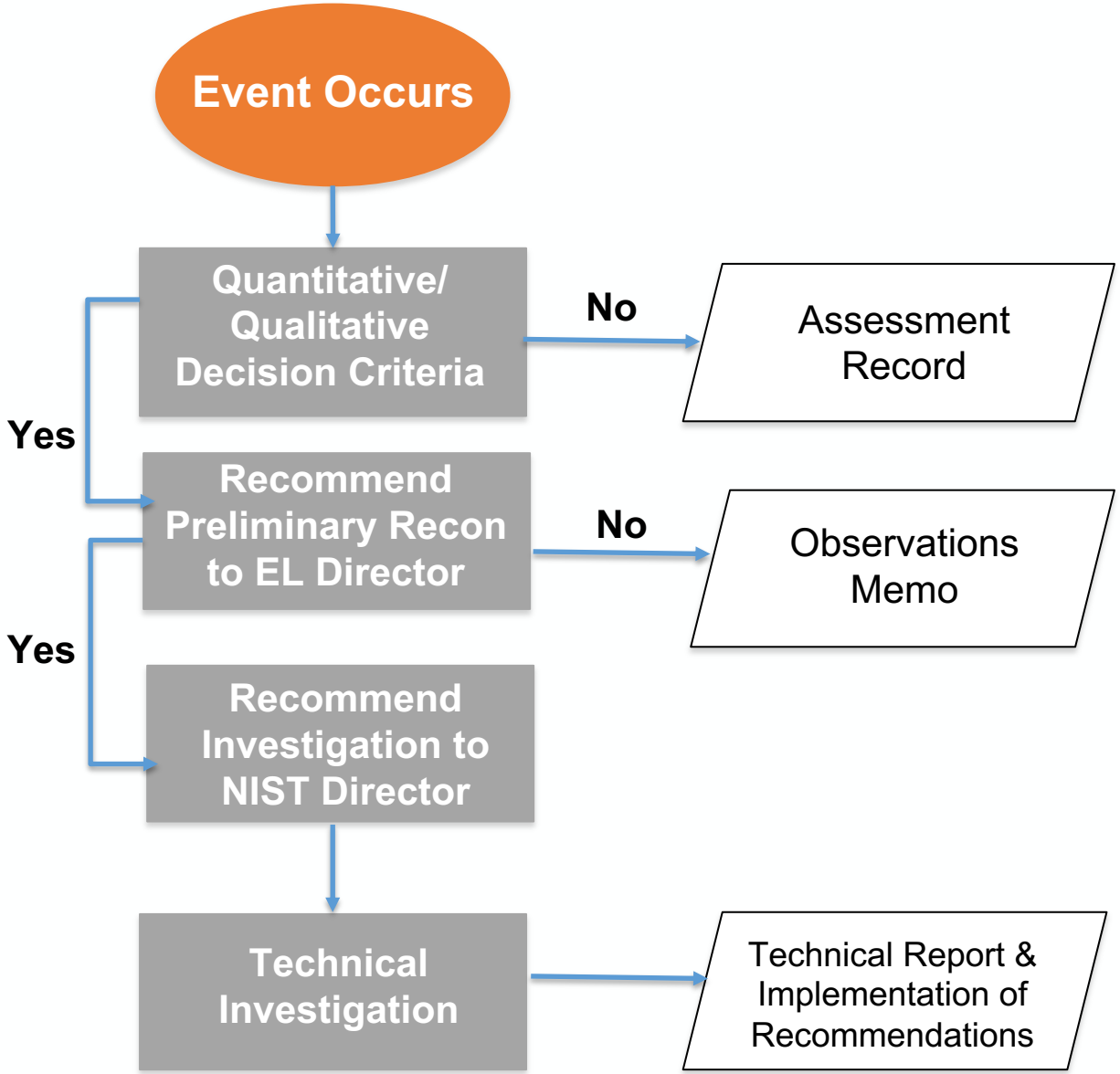
The National Construction Safety (NCST) Act

- **Public Law 107-231, Oct. 01, 2002**
  - *"…provides for the establishment of Teams to assess building performance and emergency response and evacuation procedures in the wake of any building failure that has resulted in substantial loss of life or that posed significant potential of substantial loss of life."*

- **Unique to NCST**
  - Subpoena authority
  - NIST Investigator Credentials
  - Federal Advisory Committee (up to 12 appointed members)
  - Follow through on recommendations and report(s) to Congress

Decision Process

- The initial step is the scoring of events in accordance with our decision criteria
- This score helps to inform a decision to conduct preliminary reconnaissance



Preliminary Reconnaissance Scoring Criteria - Quantitative

1.0 Event Consequence			
	Low	Medium	High
A. Mortality			
Facility context	0	1 to 2	>2
Community context[1]	0 to 3	4 to 9	>10
Regional context[2]	0 to 5	6 to 19	>20
B. Exposed Population			
Facility context	<100	100 to 499	≥500
Community context	<1 000	1 000 to 9 999	≥10 000
Regional context	<100 000	100 000 to 999 999	≥1 000 000
C. Hazard and/or Failure Intensity			
Earthquake	≤ MMI IV	MMI V to VII	≥MMI VIII
Hurricane at Landfall	≤Cat 3	Cat 4	Cat 5
Tornado	≤EF3	EF4	EF5
Coastal Inundation	< 3 ft	3 to 9 ft	≥ 10 ft
Fire Spread in Structures	Fire spread not beyond area of origin	Fire spread throughout a structure	Fire spread beyond structure of origin
Wildland Urban Interface Fire (WUI)	High Forest Service Fire Danger Rating	Very High Forest Service Fire Danger Rating	Extreme Forest Service Fire Danger Rating
Blast	< 99 lbs. TNT-equivalent	100 - 999 lbs. TNT-equivalent	> 1000 lbs. TNT-equivalent
Impact	< 1 x 10^6 ft lb/sec	1 x 10^6 to 1 x 10^7 ft lb/sec	> 1 x 10^7 ft lb/sec

Preliminary Reconnaissance Scoring Criteria - Quantitative

D. Physical Damage[1]			
Failure during Construction or in Service[2]	Minimal physical damage and/or loss of function	Moderate physical damage and/or loss of function	Severe physical damage and/or loss of function
Engineered Building Systems[3]	Minimal physical damage and/or loss of function	Moderate physical damage and/or loss of function	Severe physical damage and/or loss of function
Transportation & Utility Systems[4]	Minimal physical damage and/or loss of function	Moderate physical damage and/or loss of function	Severe physical damage and/or loss of function
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
Count x Weight:			
Event Consequence Score:			

2.0 Evacuation and Response[5]			
A. Evacuation	Normal evacuation	Moderate evacuation challenges	Severe evacuation challenges
B. Emergency Response	Normal operations	Moderate operational challenges	Severe operational challenges
Count x Weight:			
Evacuation and Response Score:			

Preliminary Reconnaissance Scoring Criteria - Qualitative

(1) What is the unique new knowledge that would be potentially gained from this study?

(2) What is the anticipated potential impact on standards, codes and practices?

(3) Do we have sufficient resources (people and funding) to support a study? If there is an existing study in the same hazard area, what is the impact on the current study?

(4) What is a current assessment of how site conditions would affect safety for a field deployment? Would current site conditions affect the timing of the field deployment?

(5) Is there a request for NIST to conduct a study by others (local, state, Federal)? If so, would NIST provide complementary expertise or would NIST have primary expertise?

(6) Does NIST have primary authority? If so, would NIST collaborate with other agencies where NIST provides complementary expertise or would NIST have primary authority and/or expertise?

Example Scoring: April 12-13 Tornado Outbreak (1/3)

1.0 Event Consequence			
	Low (1)	Med (3)	High (5)
A. Mortality			
Facility context	0	1 to 2	>2
Community context[1]	0 to 3	4 to 9	>10
Regional context[2]	0 to 5	6 to 19	>20
B. Exposed Population			
Facility context	<100	100 to 499	≥500
Community context	<1 000	1 000 to 9 999	≥10 000
Regional context	<100 000	100 000 to 999 999	≥1 000 000

Example Scoring: April 12-13 Tornado Outbreak (2/3)

C. Hazard and/or Failure Intensity			
Earthquake	≤ MMI IV	MMI V to VII	≥MMI VIII
Hurricane at Landfall	≤Cat 3	Cat 4	Cat 5
Tornado	≤EF3	EF4	EF5
Coastal Inundation	< 3 ft	3 to 9 ft	≥ 10 ft
Fire Spread in Structures	Fire spread not beyond area of origin	Fire spread throughout a structure	Fire spread beyond structure of origin
Wildland Urban Interface Fire (WUI)	High Forest Service Fire Danger Rating	Very High Forest Service Fire Danger Rating	Extreme Forest Service Fire Danger Rating
Blast	< 99 lbs. TNT-equivalent	100 - 999 lbs. TNT-equivalent	> 1000 lbs. TNT-equivalent
Impact	< 1 x 10^6 ft lb/sec	1 x 10^6 to 1 x 10^7 ft lb/sec	> 1 x 10^7 ft lb/sec
D. Consequences to resilience[3]			
Failure during Construction or in Service[4]	Minimal physical damage and/or loss of function	Moderate physical damage and/or loss of function	Severe physical damage and/or loss of function
Engineered Building Systems[5]	Minimal physical damage and/or loss of function	Moderate physical damage and/or loss of function	Severe physical damage and/or loss of function

Example Scoring: April 12-13 Tornado Outbreak (3/3)

Transportation & Utility Systems[6]	Minimal physical damage and/or loss of function	Moderate physical damage and/or loss of function	Severe physical damage and/or loss of function
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
Count x Weight:	0 x 1 = 0	4 x 3 = 12	1 x 5 = 5
Event Consequence Score:	**17/5 = 3.4**		

2.0 Evacuation and Emergency Response[7]			
Evacuation	Normal evacuation	Moderate evacuation challenges	Severe evacuation challenges
Emergency Response	Normal operations	Moderate operational challenges	Severe operational challenges
Count x Weight:	0 x 1 = 0	2 x 3 = 6	0 x 5 = 0
Evacuation Score:	**Score: 6/2 = 3.0**		

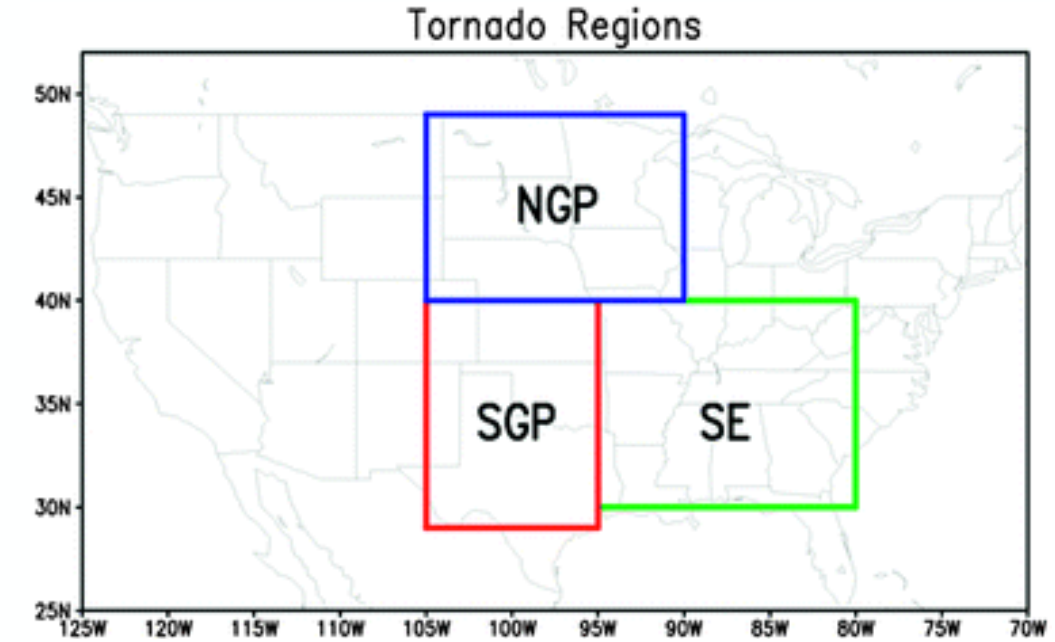
Example Scoring:
April 12-13 Tornado Outbreak

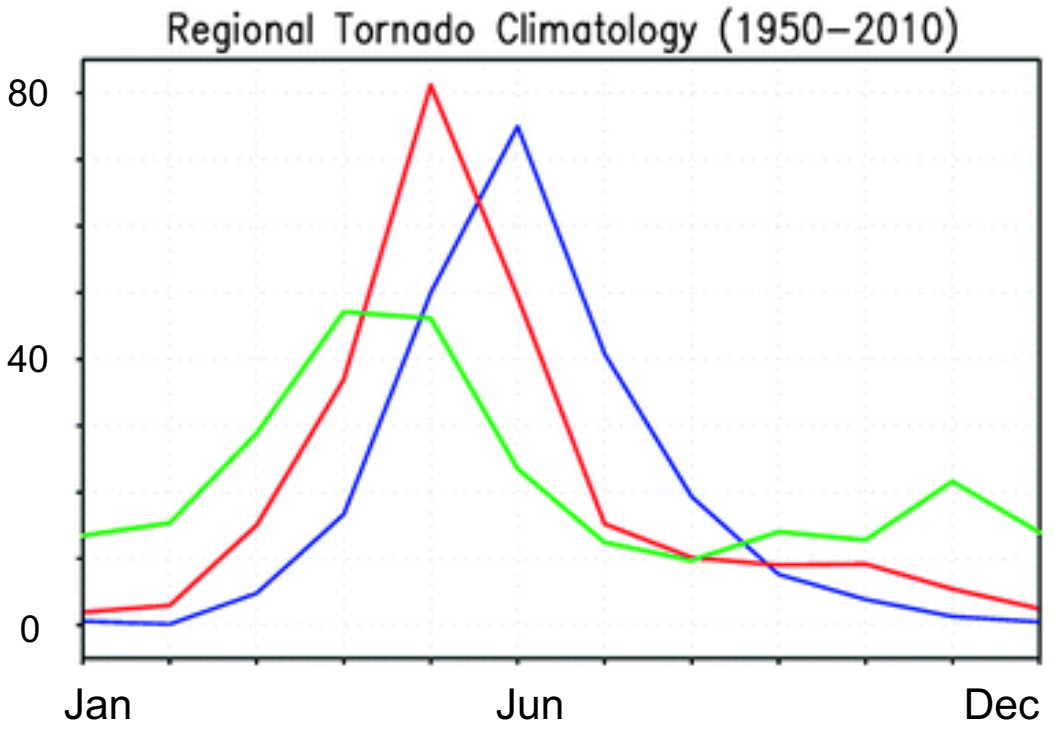
Summary Assessment:
Beginning on 4/12/20 and lasting into 4/13/2020, a major severe weather outbreak caused fatalities and damage across the Southeastern U.S. The outbreak included high winds and at least 140 tornadoes reported in Texas, Louisiana, Mississippi, Alabama, Florida, Georgia, Tennessee, South Carolina, North Carolina, and Maryland including 3 EF4s and 12 EF3s.[1]

The outbreak has caused 36 fatalities.[2] Thousands of buildings were either heavily damaged or completely destroyed. Airport facilities were damaged in Monroe, LA and Walterboro, SC. The total cost of the outbreak has been estimated by NOAA to be $3.6 B.[1]

Sheltering policies in this event were impacted by the COVID-19 pandemic. Social distancing restrictions enacted in response to the pandemic caused confusion among officials and citizens regarding the status of shelters. In some scenarios, officials withdrew social distancing guidelines for tornado shelters. There was at least one case of local officials refusing to comply with a governor's orders to open shelters.[3]

[1]https://www.ncdc.noaa.gov/billions/events
[2]https://www.washingtonpost.com/weather/2020/04/16/by-numbers-easter-weekend-tornado-outbreak-was-unusual/
[3]https://www.wbrc.com/2020/04/11/easter-tornado-threat-poses-safety-dilemma-during-pandemic/





Weaver et al., 2012 with permission

Question 1: What is the unique new knowledge that would be potentially gained from this study?

- **This study could contribute to understanding the following: In multi-hazard scenarios (e.g., hazard event, pandemic) such as this, how are decisions made to protect public safety, who is involved in the decision-making, how is information distributed to protect lives, and what measures could ensure that information from different sources or levels of government are not in conflict?** Would standardized guidelines, best practices, etc. improve the operations of government and emergency management officials and aid public health and safety?
- There are **significant potential impacts to Codes, Standards and Guidance in this area, including NIST work to implement Joplin Recommendation #8 on developing guidance for public tornado shelter planning, design and operations as well as NIST work on the ASCE/SEI/AMS Standard for Wind Speed Estimation in Tornadoes (implementation of Joplin Recommendation #4 – improving EF Scale).** There is a unique opportunity related to one of the tornadoes in Monroe, Louisiana that struck the airport. **The Committee working on the ASCE/SEI/AMS Standard for Wind Speed Estimation in Tornadoes is hoping this event can be used for a cross comparison of some or all of the tornado wind speed estimation methods (radar, in situ, EF Scale, Forensic Engineering, treefall pattern analysis, and remote sensing of damage) to help validate/improve the proposed methods in the standard.**

Additional Qualitative Input: Questions 2-3

What is the anticipated potential impact on standards, codes and practices?

- Community planning and emergency management practices could be updated based on lessons learned and guidance created from knowledge gained by answering questions listed in 1.
- Additionally, the findings could impact ICC 500 storm shelter standard and FEMA 361 Community Safe Room Guidance, both of which are undergoing changes and are therefore, open for input.
- This would help support implementation of Joplin Recommendation 8 on guidance for public tornado shelters.
- Also potential support for implementation of Joplin Recommendation 4 on improving EF Scale and the ASCE/SEI/AMS Standard on Wind Speed Estimation in Tornadoes and Other Windstorms.

Do we have sufficient resources (people and funding) to support a study? If there is an existing study in the same hazard area, what is the impact on the current study?

- It would be challenging for NIST to deploy while stay at home orders are in place for many states across the US due to the COVID-19 pandemic. However, given the potential to use existing contract vehicles and contract personnel that may be within driving distance or local, there may be a means by which to resource the preliminary reconnaissance. The benefits of gaining the perishable data in the specific case of Monroe, Louisiana are substantial.

Additional Qualitative Input: Questions 4-6

What is a current assessment of how site conditions would affect safety for a field deployment? Would current site conditions affect the timing of the field deployment?

- Physical site conditions would likely not affect a deployment, although COVID-19 guidance for community health would discourage a deployment.

Is there a request for NIST to conduct a study by others (local, state, Federal)? If so, would NIST provide complimentary expertise or would NIST have primary expertise?

- …interest among members of the committee working on the ASCE/SEI/AMS Standard for Wind Speed Estimation in Tornadoes (implementation of Joplin Recommendation #4 – improving EF Scale), including:
  - Insurance Institute for Business & Home Safety (IBHS)
  - National Weather Service, Shreveport, LA
  - Metal Building Manufacturers Association

Does NIST have primary authority? If so, would NIST collaborate with other agencies where NIST provides complimentary expertise or would NIST have primary authority and/or expertise?

- Yes (the National Construction Safety Team Act, National Windstorm Impact Reduction Program, NIST Organic Act); we also have expertise in wind and structural engineering, and standards for building to resist tornadoes

Disasters Scored Dec 2019-Oct 2020

**NIST deployed*
***NIST Disaster Resilience Grantee deployed*
+NIST participated in virtual reconnaissance

Date	Event	Event Consequence Score (max=5.0)	Evacuation & Response Score (max=5.0)
12/17/19	Southeastern US Tornadoes (Louisiana, Mississippi, Alabama, Georgia)	2.8	1.0
01/07/20	Indios Earthquake Sequence (Puerto Rico)+	3.9	3.0
01/10/20	Australian Firestorm (Australia)	4.5	3.0
01/15/20	Building Collapse (Washington, DC)	1.8	1.0
01/24/20	Doganyol Earthquake (Turkey)	3.5	4.0
01/24/20	Houston Plant Explosion (Texas)	4.0	1.0
01/28/20	Lucea Earthquake (Jamaica)	1.2	1.0
03/03/20	Tennessee Tornadoes (Tennessee)**	3.3	3.0
03/18/20	Magna Earthquake (Utah)	3.0	2.0
03/24/20	Tishomingo Tornado (Mississippi)	1.8	1.0
03/28/20	Jonesboro Tornado (Arkansas)	2.2	2.0
04/13/20	Multi-state Tornado Outbreak (TX, LA, MS, AL, FL, GA, TN, SC, NC, MD)	3.4	3.0

Disasters Scored Dec 2019-Oct 2020, Continued

**NIST deployed*
***NIST Disaster Resilience Grantee deployed*
+NIST participated in virtual reconnaissance

Date	Event	Event Consequence Score (max=5.0)	Evacuation & Response Score (max=5.0)
05/02/20	Indios Earthquake Sequence (Puerto Rico)+	2.7	2.0
05/15/20	Tonopah Earthquake (Nevada)	1.7	1.0
05/16/20	Los Angeles Building Explosion (California)	2.8	5.0
06/23/20	Oaxaca Earthquake (Mexico)	3.0	2.0
06/24/20	Lone Pine Earthquake (California)	1.3	1.0
8/11/2020	Midwest Derecho (Iowa, Illinois)**	3.4	3.0
8/27/2020	Hurricane Laura (Louisiana, Texas)**	4.1	3.0
10/9/2020	Hurricane Delta (Mexico, Louisiana)**+	1.3	1.0
9/16/2020	California Fire Complex	4.0	3.0
9/16/2020	Oregon Fire Complex	3.5	3.0

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Questions?

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