DFS Updates on Enhancing the Readiness of Teams

Aug 30, 2018
NCST Advisory
Committee Meeting

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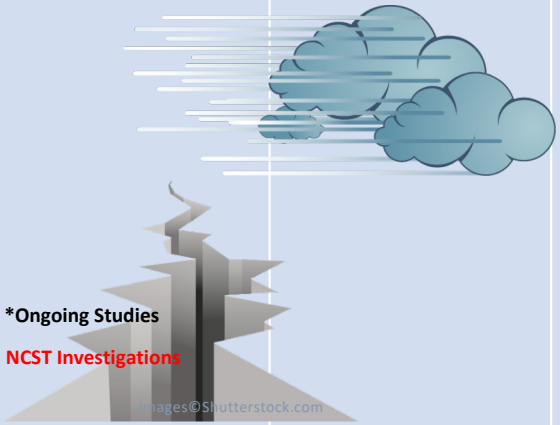
National Institute of Standards and Technology

Long History of Disaster and Failure Studies at NIST

Earthquakes

San Fernando, CA (1971)
Mexico City, Mexico (1985)
Loma Prieta, CA (1989)
Northridge, CA (1994)
Kobe, Japan (1995)
Kocaeli, Turkey (1999)
Maule, Chile (2010)
Christchurch, NZ (2011)
***Puebla, Mexico (2017)**



***Ongoing Studies**
NCST Investigations

Hurricanes

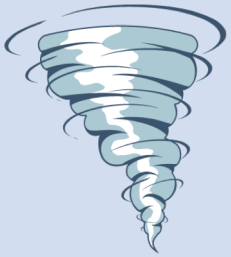
Camille, MS/LA (1969)
Alicia, Galveston, TX (1983)
Hugo, SC (1989)
Andrew, FL (1992)
Fran, NC (1996)
Mitch and Georges, LAC (1998)
Katrina and Rita (2005)
***Matthew, NC (2016)**
***Harvey, TX (2017)**
***Maria, PR (2017)**

Construction & Building

Skyline Plaza Apartments, Bailey's Crossroads, VA (1973)
Willow Island Cooling Tower, WV (1978)
Kansas City Hyatt Regency, Kansas City, MO (1981)
Riley Road Interchange, East Chicago, IN (1982)
Harbor Cay Condominium, Cocoa Beach, FL (1981)
L'Ambiance Plaza, Hartford, CT (1987)
Ashland Oil Tank Collapse, Floreffe, PA (1988)
U.S. Embassy, Moscow, USSR (1987)
Murrah Federal Building, Oklahoma City, OK (1995)
World Trade Center Disaster, New York, NY (2001)
Dallas Cowboys Indoor Practice Facility, May 2009

Tornadoes

Jarrell, TX (1997)
Spencer, SD (1998)
Oklahoma City, OK (1999)
Joplin, MO (2011)
Moore OK (2013)



Fires

DuPont Plaza Hotel, San Juan, PR (1986)
First Interstate Bank Building, Los Angeles, CA (1988)
Loma Prieta Earthquake, CA (1989)
Hillhaven Nursing Home (1989)
Pulaski Building, Washington, DC (1990)
Happyland Social Club, Bronx, NY (1990)
Oakland Hills, CA (1991)
Watts St, New York City (1994)
Northridge Earthquake, CA (1994)
Kobe, Japan (1995)
Vandalia St, New York City (1998)
Cherry Road, Washington, DC (1999)
Keokuk, IA (1999)
Houston, TX (2000)
Phoenix, AZ (2001)
Cook County Administration Building Fire (2003)
The Station Nightclub, RI (2003)
Charleston, SC, Sofa Super Store Fire (2007)
Witch Creek & Guejito, CA, WUI Fire (2007)
Amarillo, TX, WUI Fire (2011)
San Francisco, CA (2012)
***Gatlinburg, TN WUI (2016)**
***Fuse-47, MD (2017)**

NIST's Disaster and Failure Studies Program

Statutory Thrust

Procedures Thrust

Research Thrust

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Statutory Thrust

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Prioritizing DFS Field Activities

(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?

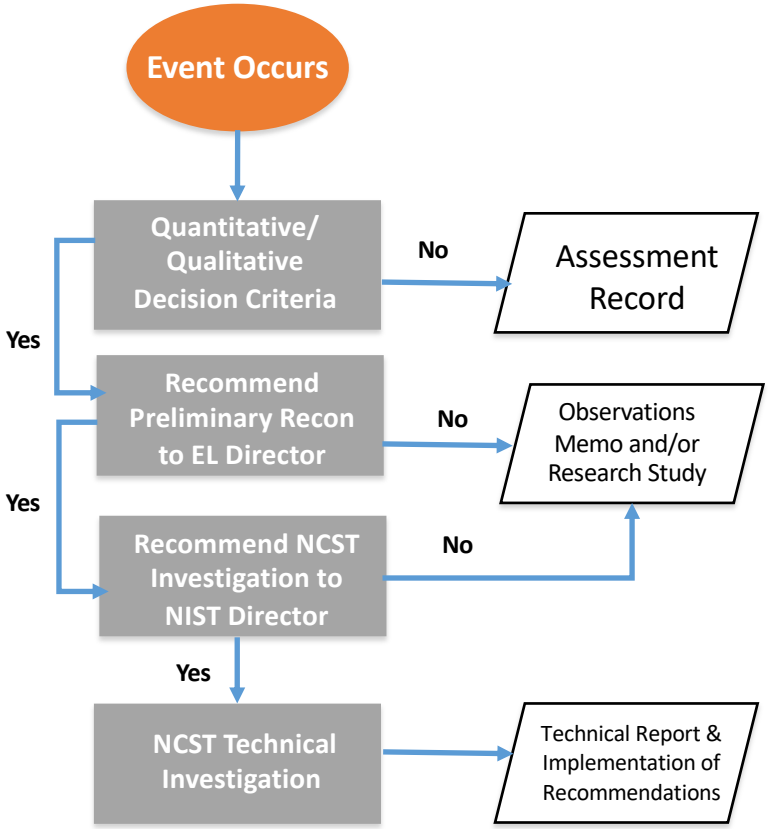
(5) Is there a request for NIST to conduct a study by others (local, state, Federal)? If so, would NIST provide complementary expertise or would NIST have primary expertise?

(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?

Quantifying Events and Process Flows

1.0 Event Consequence			
	Low	Medium	High
A. Mortality			
Facility context	0	1 to 2	>2
Community context	0 to 3	4 to 9	>10
Regional context	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
D. Physical Damage			
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
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
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
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			
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:			



Scored Disasters since last In-Person NCST AC Meeting		
Date	Event	Event Consequence Score Evacuation & Response Score
08/25/18	Hurricane Lane (Hawaii)	**2.0/5.0** **1.0/5.0**
08/05/18	Loloan Earthquake (Indonesia)	**3.4/5.0** **2.9/5.0**
07/30/17	Carr WUI Fire (Redding, CA)	**2.5/5.0** **3.0/5.0**
07/23/18	Greek WUI Fires (Kineta, Mati, and Rafina, Greece)	**2.8/5.0** **3.2/5.0**
07/23/18	Apartment Building Collapse (Miami Beach, FL)	**3.0/5.0** **1.0/5.0**
05/04/18	Leilani Estates Earthquake (HI)	**3.0/5.0** **3.0/5.0**
05/01/18	Fire Induced Building Collapse (São Paolo, Brazil)	**3.6/5.0** **3.6/5.0**
03/15/18	FIU Pedestrian Bridge (Miami, FL)	**4.2/5.0** **3.0/5.0**
12/28/17	Bronx Apartment Fire (New York City, NY)	**3.0/5.0** **2.0/5.0**

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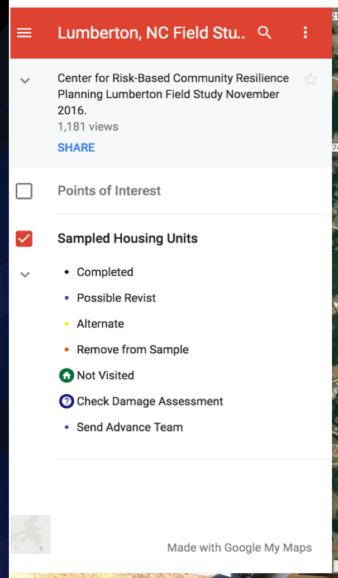
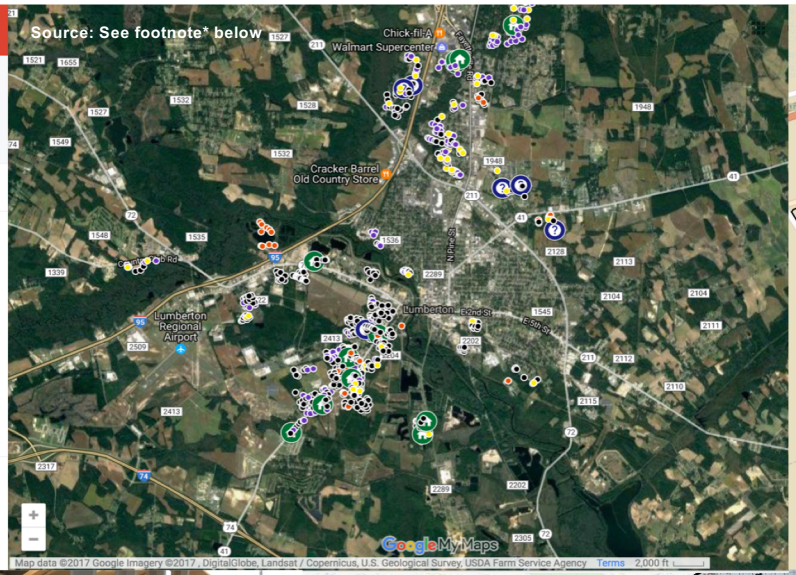
Procedures Thrust

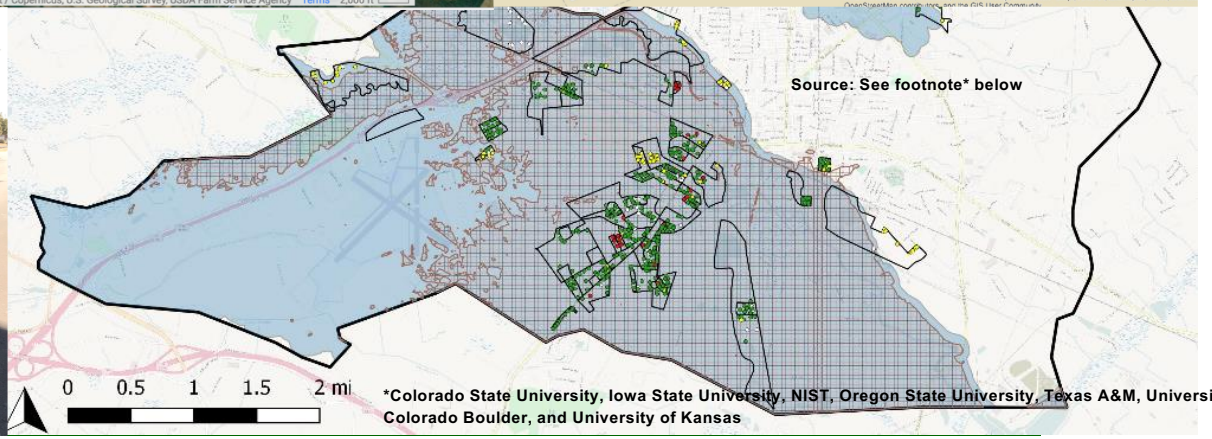
- DFS SOP
- HOT Team membership, training, and credentials
- Field and safety protocols
- Human subjects protocols
- Manage equipment for disaster metrology and personnel protection
- Data preservation, security, and management plan
- Field tools (NDA's, permissions, survey inst.)
- MOUs with other agencies, academics, and others
- NIST Disaster Working Group

Research Thrust

Sampling Methods and Field Equipment







*Colorado State University, Iowa State University, NIST, Oregon State University, Texas A&M, University of Colorado Boulder, and University of Kansas

New Impact/Recovery Instruments

North Carolina Flood Field Study: Household Survey

Note these initial questions are answered with respect to the sampled Housing Unit (HU) and the structure in which it is located.

Housing Unit/Sample Unit Description:			**Address:**_____ **Verified by Respondent?** YES NO		
Interview Attempt 1: Date/Time:		**Interview Attempt 2:** Date/Time:		**Interview Attempt 3:** Date/Time:	
Building Type:	1. Single Family	2. Multi-Family # of HUs _____	3. Manufactured/ Mobile home	4. Other: Describe	
Housing Unit (HU) appears occupied Habited or not habited?	YES: household present	YES, evidence of current habitation	Yes, occupied confirmed by neighbor	NO: not occupied, appears abandoned	NO, damage and not habitable
		Yes, occupied, confirmed by management	DK: Indeterminate/ uncertain	NO: not occupied, under repair/reconstruction.	
Interview Attempt Result code:	Result of Interview attempt 1: _____	Result of Interview attempt 2: _____	Result of Interview attempt 3: _____	**Appointment or follow up: day and time**	Day/time:_____
	Result/ completion codes: 1. **Completed interview** 2. **Incomplete/partial** - 3. **Not available or inconvenient** (try to avoid and set , appointment set	4. **Soft refusal** – closing team assignment. 5. **Hard Refusal** – contact captain, perhaps replacement 6. **No Answer** or response, but evidence or confirmed occupied.	7. **Ineligible,** (needs follow interview attempt) 8. **Ineligible** (with information about previous residents)	9. **Ineligible total** – new construction – post HM 10. **Ineligible property** – structure not a residence 11. **Bad address** – could not locate HU.	12. **Not occupied residence,** abandoned property, home destroyed. 13. **No access.** Gated community or safety fence preventing entry to damage residence(s). *NOTE IF structure destroyed or abandoned, code as 12.*

Assessment of occupancy and information about HU and household gained from neighbors, apartment managers, etc.

Does the Housing Unit appear to be currently occupied?	YES NO DK	IF YES: nature / source of the evidence: ____ Other: _____	**If Neighbor, manager, or other person can provide information**	Was the HU occupied at time of HM?: YES NO	If YES: # of persons _____	
Evidence that Housing unit was occupied at the time of HM?	Yes NO DK	IF YES: nature of the evidence: ____ Other: _____		Is same household there now? YES NO DK	If YES: # of persons _____	If No: Will former HH return? YES NO DK
	1. Signs of current/previous occupancy 2. Neighbor 3) Management 4) other – specify in space			If NO: New residents in HU? YES NO DK	If YES: # of persons _____	
Space for Additional Comments/Observations:						

Community Resilience in Disaster and Failure Studies

Identify Important Social Dimensions to Prioritize Deployment Activities

- **Family/Kinship**
- **Education**
- **Health**
- **Government**
- **Economy**
- **Media**
- **Community-based Organizations**

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Research Thrust

- Research program focused on disaster metrology, including structural performance and social sciences
- Coordinate research activities with NIST EL Groups, disaster statutory programs, NIST EL Divisions, and other NIST Labs
- Coordination with the Center of Excellence of Risk-Based Community Resilience Planning on field studies
- NIST's Disaster Resilience Grants Program
- Outreach and dissemination

NIST Research Summary

NIST research is focused on using disaster metrology to answer important questions at the interface of physical and societal systems:

- Collect data and establish likely technical factors responsible for performance of buildings and infrastructure after disasters.
- Collect data related to community impact and recovery.
- Collect data to validate models (e.g., IN-CORE).
- Test novel field hardware and software.
- Identify best practices for setting regional scope, sampling protocols, and frequency of data collection.
- Recommend, as necessary, specific improvements to standards, codes, and practices based on field studies.

Recent DFS Deployments, Studies, and Investigation

- **Ongoing Non-NCST Studies**
  - 2016 Hurricane Matthew with CoE (Lumberton, NC)
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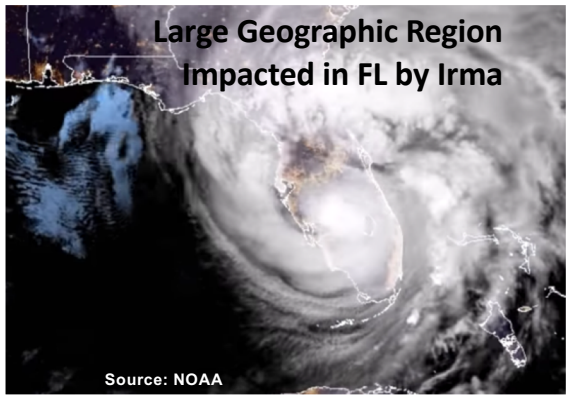

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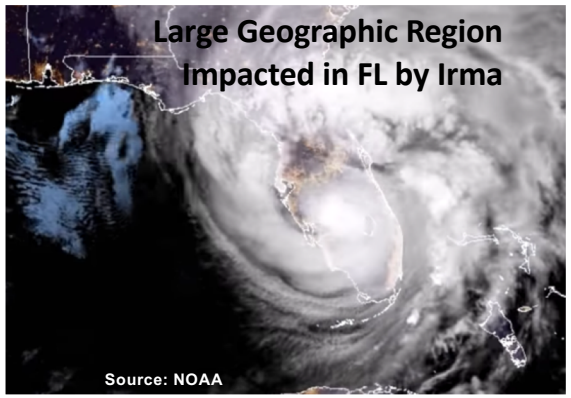

Longitudinal Studies Inform Community Resilience Models

Hazard Event	Wave 1	Wave 2	Wave 3
October 2016	November 2016	January 2018	Fall/Winter 2018

- A longitudinal study is a methodological approach that allows the same cases to be observed over time to track changes (positive and negative).
- Recovery is not a single event, but a process; repeated observations of a sample of housing units, schools, and businesses are needed to capture recovery.

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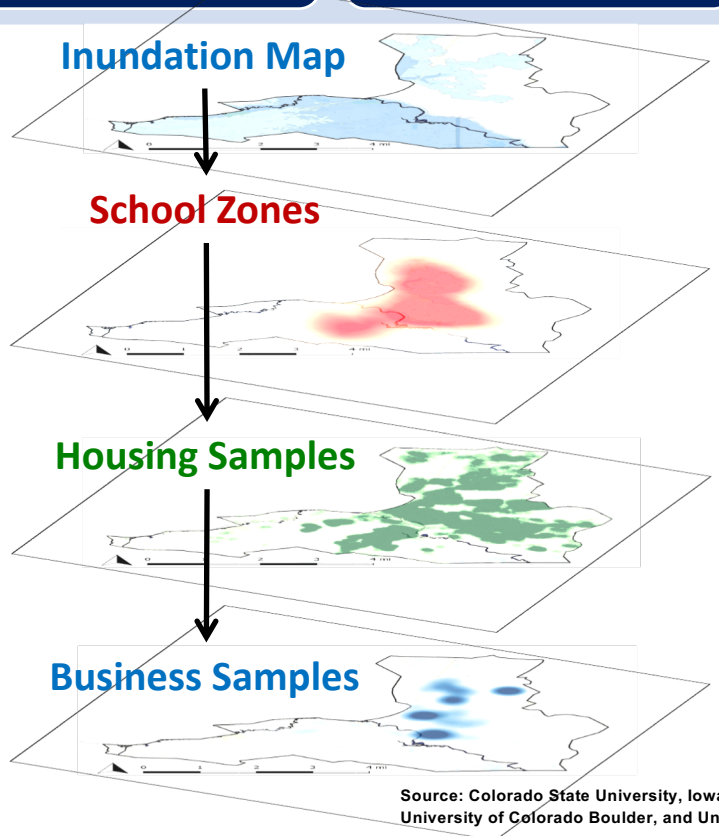

Source: Colorado State University, Iowa State University, NIST, Oregon State University, Texas A&M, University of Colorado Boulder, and University of Kansas

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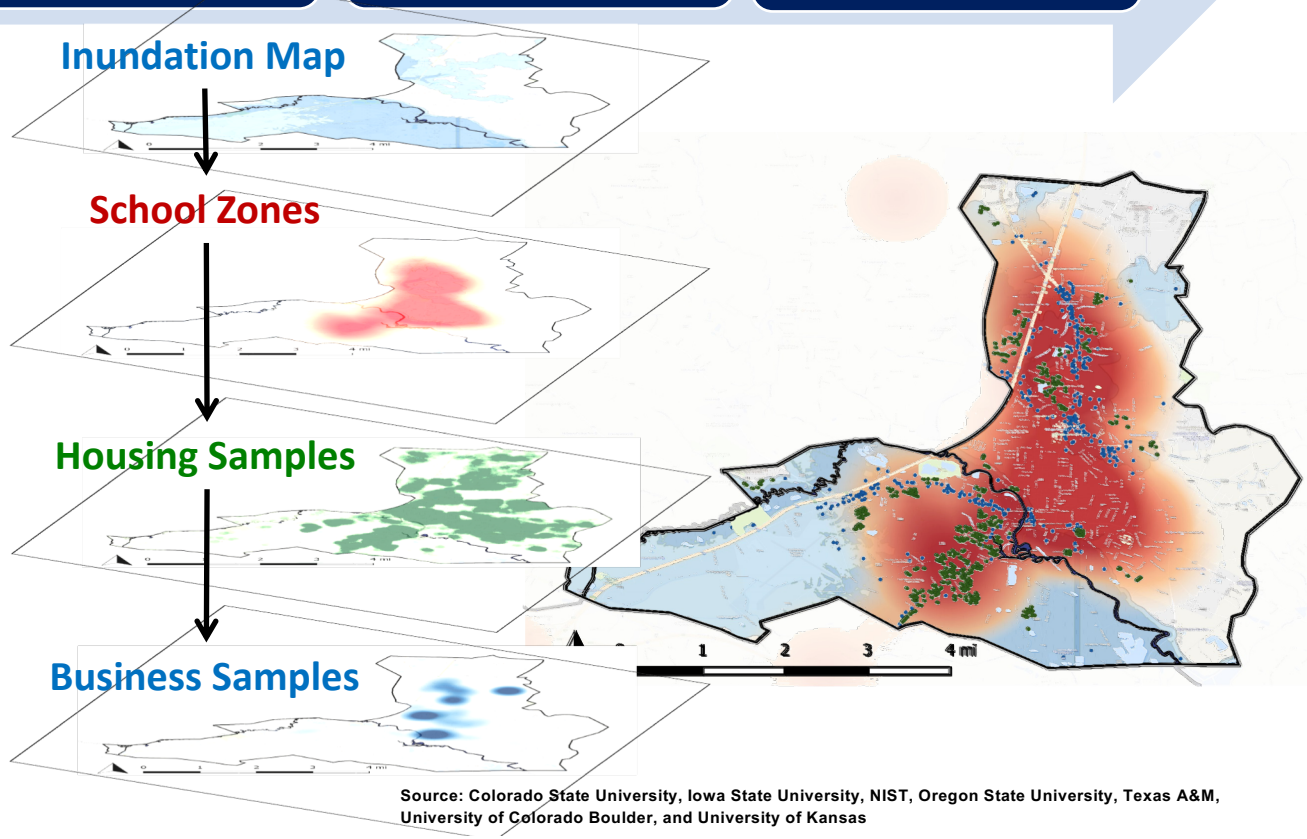

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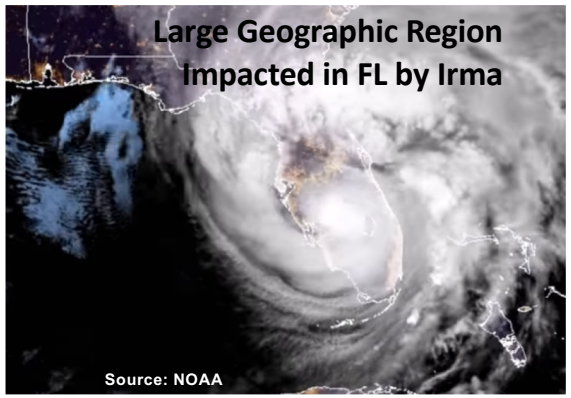

Did late evacuation notices contribute to fatalities in Gatlinburg?

WUI Group developed survey instruments to study evacuations, communications, and response efforts:

- Incident Command situational awareness and decision-making surrounding the need to evacuate affected communities
- Emergency communications between fire incident managers and public
- Public response (including causes of deaths from this fire)

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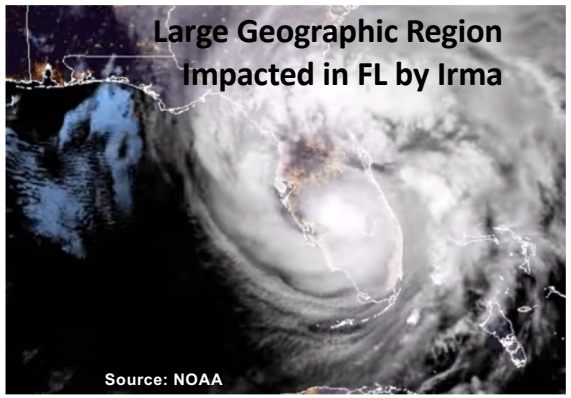
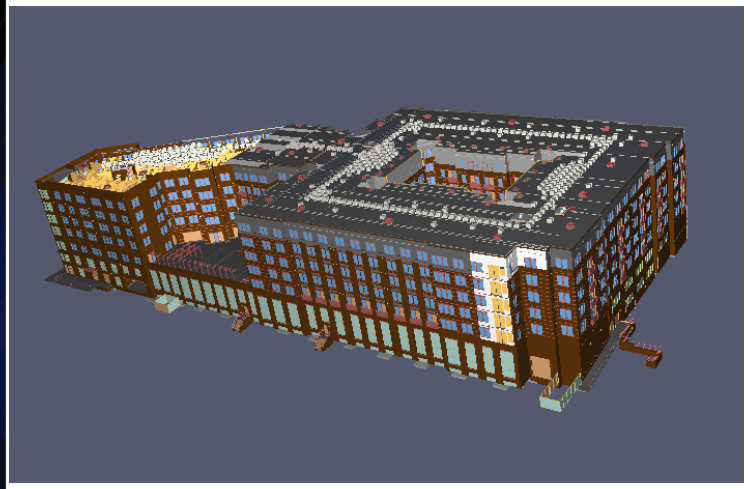
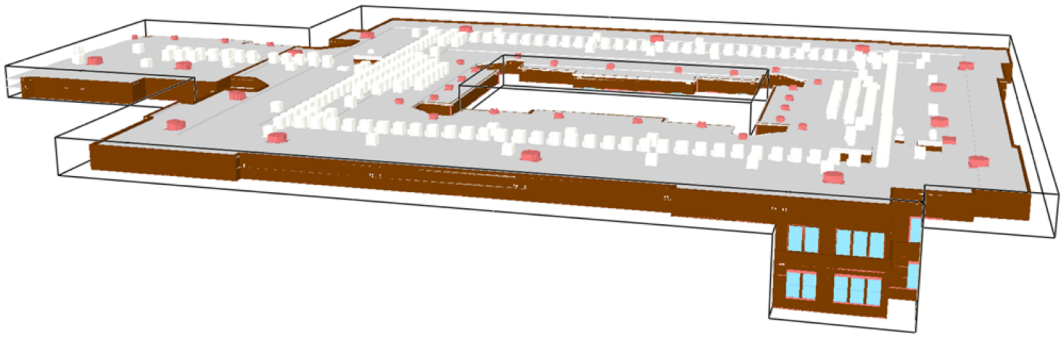
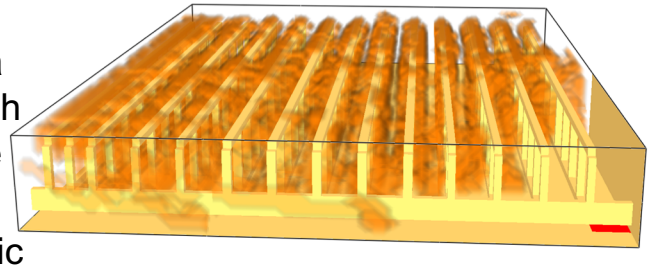


Chronic Disaster in the US: Construction-Related Fires





- 3750 construction related fires between 2010-2014*
- 2015 IBC allows for up to 5 floors of wood ”stick built” with 1-2 floor pedestal
- Fuse-47 had 2-levels of concrete & 5 levels of wood construction
- Fire modeling underway with NIST Fire Dynamics Simulator (FDS): a fine grid is used for the fire apartment (6th floor), apartment above with ceiling opening (7th floor), and the attic space; a course grid for entire wood portion of building
- Study seeks to answer: how did fire spread? would fire barriers in attic limit the spread? would working sprinklers have suppressed the fire?



* Campbell, R., 2017. “Fires in Structures Under Construction, Undergoing Major Renovation, or Being Demolished,” NFPA Report No. #2772, April 2017.

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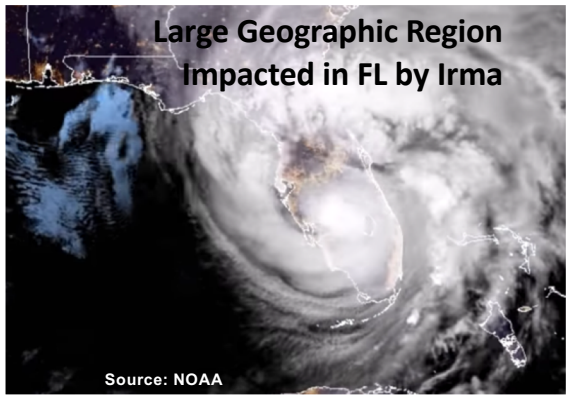
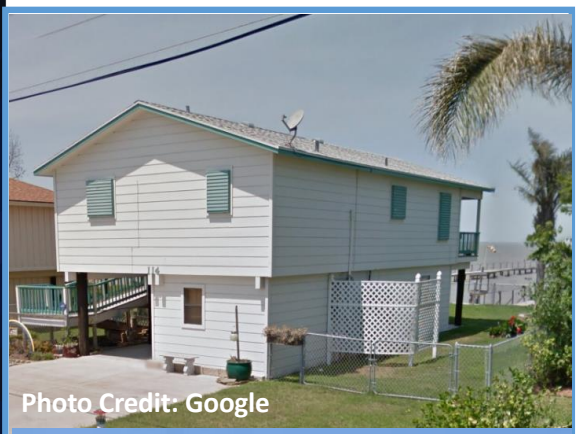


How well do our codes and mitigation strategies hold up?



Key Observations:

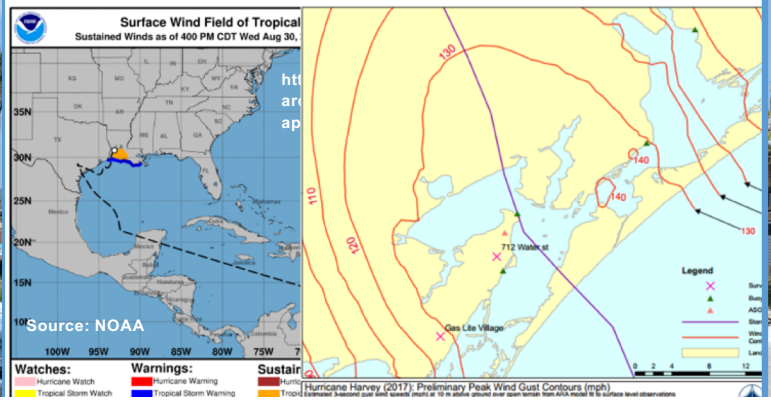
(1) damage from multiple sources (wind, wind-borne debris, wind-driven rain, and storm surge) in initial landfall area,

(2) extensive wind-induced damage to metal buildings and wood-framed single family homes,

(3) good performance of recent construction,

(4) penetration of wind-driven rain caused extensive damage, sometimes due to inadequately anchored rooftop equipment,

(5) good performance of flood-proofing strategies of critical infrastructure.



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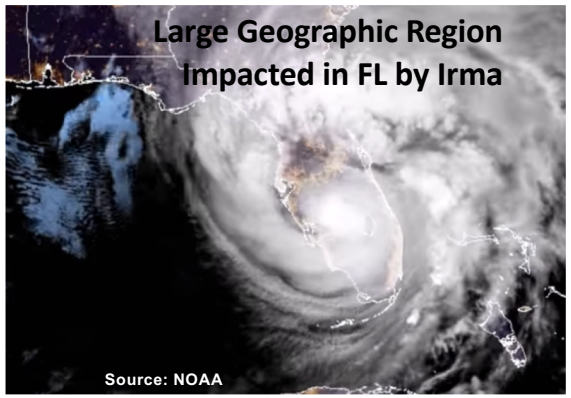

Thank you

Judith Mitrani-Reiser, Ph.D.
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