Standards for Disaster Resilience for Buildings and Infrastructure Systems

Advisory Committee on Earthquake Hazards Reduction

November 8, 2011

Stephen A. Cauffman

Deputy Chief, Materials and Structural Systems Division

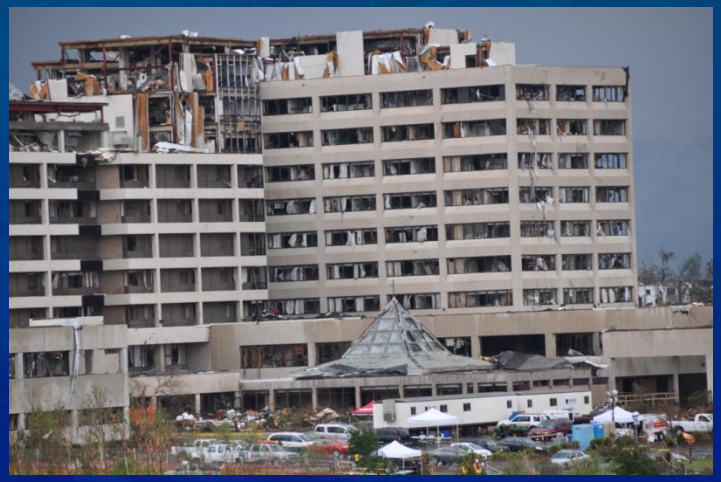
NIST
National Institute of Standards and Technology
U.S. Department of Commerce

Outline

- Background
- Resilience Concept
- Approach
- Engagement with Stakeholders
- Next Steps

Background

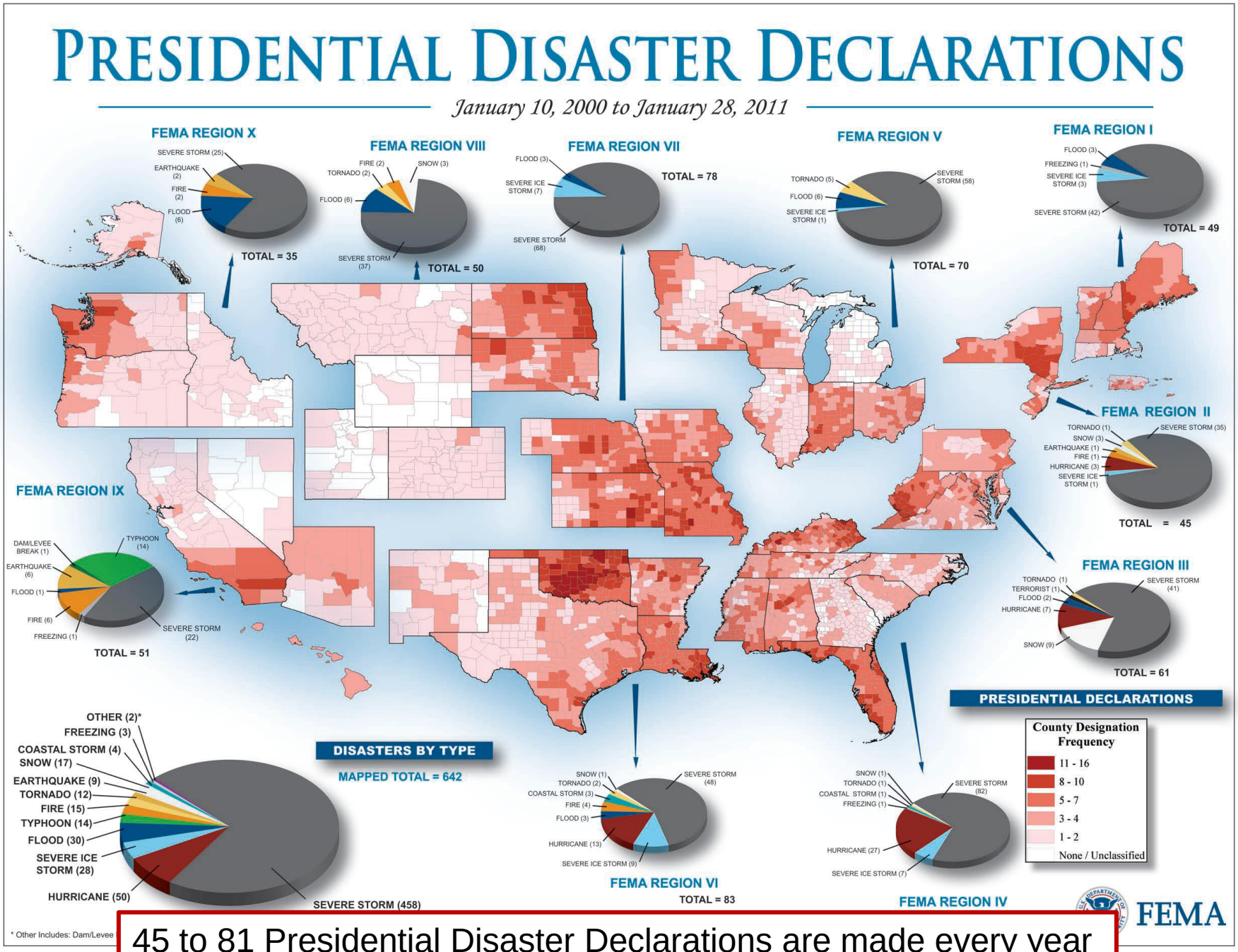
- Natural and technological disasters cause an estimated $57B in average annual costs (and growing), with catastrophes like Hurricane Katrina and future “Kobe” earthquakes causing mega-losses exceeding $100B.
- Existing extreme load-related prescriptive requirements of building codes, standards, and practices stifle design and construction innovation and increase construction costs by an estimated $50B-$100B per year.



The risk in large disaster-prone regions of the Nation is substantially greater now than ever before due to the combined effects of development and population growth.

“…a primary focus on response and recovery is an impractical and inefficient strategy for dealing with [natural disasters]. Instead, communities must break the cycle of destruction and recovery by enhancing their disaster resilience.”

National Science & Technology Council, *Grand Challenges for Disaster Reduction – A Report of the Subcommittee on Disaster Reduction*, June 2005.



45 to 81 Presidential Disaster Declarations are made every year

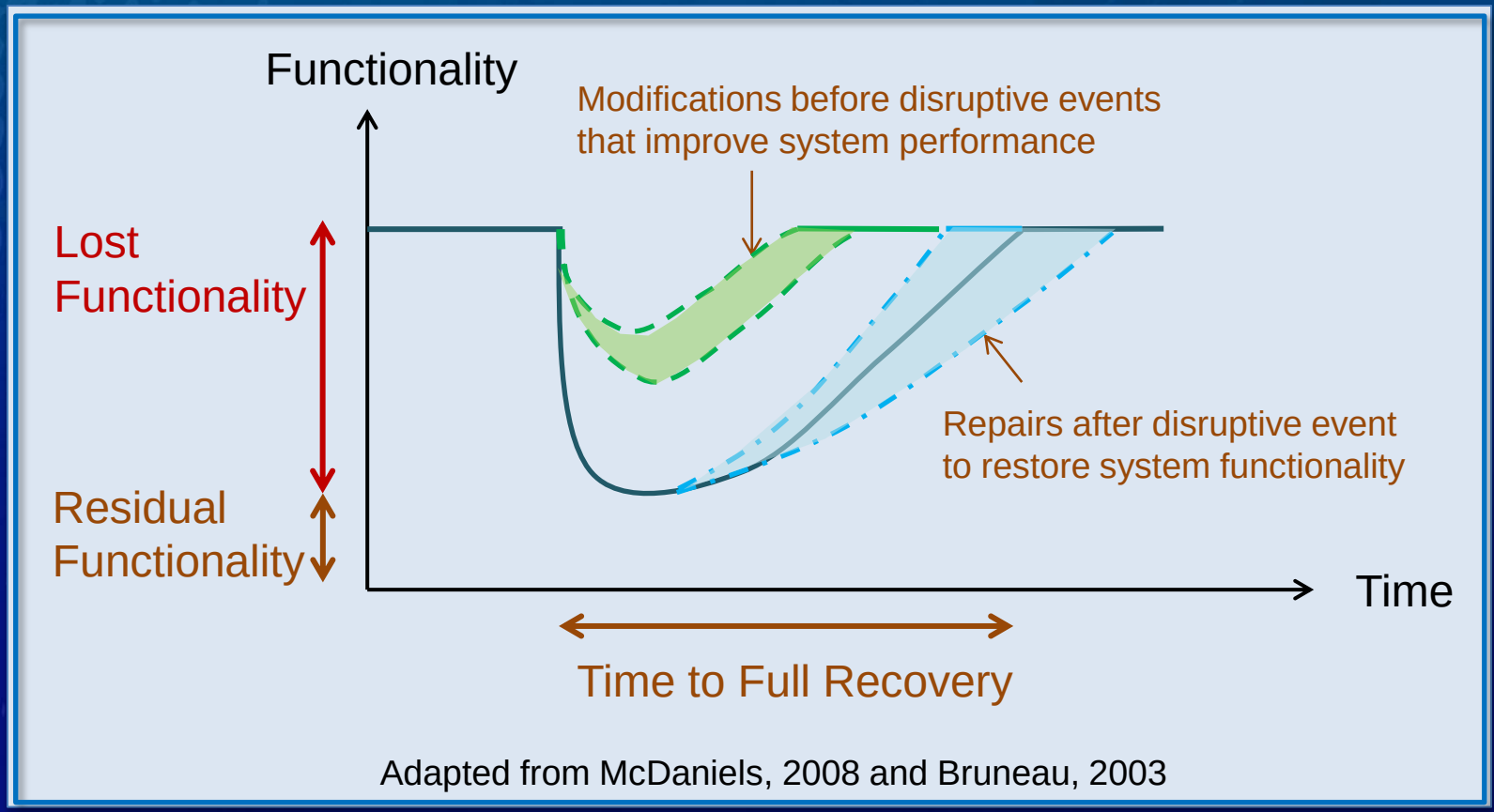
Performance of the Built Environment

- The built environment fails repeatedly during hazard events
- Performance of the built environment is dependent the codes and standards in place at the time of construction, enforcement, maintenance, and operation
- The built environment is highly interconnected; current codes and standards are generally independent and do not account for this interconnectedness

Resilience Concepts

Resilience is the capability of a system to

- maintain acceptable levels of functionality during and after disruptive events
- to recover full functionality within a specified period of time



Adapted from McDaniels, 2008 and Bruneau, 2003

Defining the Built Environment

- Buildings (engineered and non-engineered)
  - All systems necessary for intended function
  - Architectural, structural, life safety, mechanical, electrical, plumbing, security, communication and IT systems
- Infrastructure or lifelines
  - Transportation - roads, bridges, tunnels, ports, rail
  - Utility plants and distribution systems - electric power, water and wastewater, fuels, communication

Community Resilience

- Identify multiple hazard and performance levels
- Consider the function of buildings and infrastructure systems within the context of response and recovery.
  - *What* is the required function of the building or infrastructure system?
  - *When* is the building or infrastructure system required to be restored to functionality to support response and recovery?

Framework for Resilience Standards

Present

System of “stovepiped” design standards for *resistance* to hazards or *reliability of service*

Future

Holistic approach to resilience standards that incorporate *resistance* to and *recovery* from hazard events

Common Terminology/Definitions

- Hazard levels
  - Routine (serviceability)
  - Expected (used in design and to evaluate resilience)
  - Extreme (used in emergency response planning)
- Performance levels
  - Account for function of building or infrastructure system within the context of the community
  - Consider time to return to functionality

Performance Goals/Categories

- Develop performance goals for buildings and infrastructure systems
  - System-wide, interdependent approach
  - Guidelines for rural and urban communities
- Develop performance categories for buildings and infrastructure systems
  - Performance level tied to role of building or infrastructure system in response and/or recovery following a hazard event
  - Generalized for new and existing systems

Identify Gaps in Standards, Codes, and Current Practice

- Hazards and associated load criteria
- Hazards without load criteria (e.g., fire)
- Performance criteria for construction materials and types
- Interdependencies among buildings and infrastructure systems
- Examples from best practices (e.g., for business continuity)

Metrics and Performance Level Criteria

- New construction
- Existing buildings and infrastructure systems incorporating aging effects
- Upgrading of existing buildings and infrastructure systems
- Across segmented infrastructure sectors (e.g., electric power generation, transmission, distribution)
- Associated costs to restore full capacity and/or functionality
- Applied across hazard levels and performance categories

Technical Basis for Resilience Design

- Improved analysis procedures for structural systems to enable use of structural performance levels for resilience
- Performance criteria for the building envelope and non-structural building systems

Metrics for Community Resilience

- Account for interdependencies among buildings and infrastructure systems
- Incorporate performance

What is Needed to Achieve Resilient Communities?

Status Quo

- Prescriptive codes and standards for life safety
- Poor buildings and infrastructure resilience performance during hazard events
- Emergency response planning but little community resilience planning
- Reliance upon federal disaster funding for recovery

Moving Forward

- Risk consistent, performance based codes and standards for resilience
- Comprehensive approach to design guidance for built environment
- Proactive planning by communities to achieve resilience
- Reduced emergency response and recovery costs

Stakeholder Engagement

- Invitation-only roundtable held September 26.
  - Engineering community, SDOs, insurance industry, government
  - Hosted by ANSI-HSSP; organized by NIST; supported by DHS
- Group help to identify and refine the needs presented here.
- Strong general sense that resilience is the direction that the industry needs to move
- Recognition that this is a long-term process

Stakeholder Engagement (2)

- Preparing for open workshop on November 10
- Hosted by ANSI-HSSP; organized by NIST
- Speakers from engineering profession, infrastructure sectors
- Review/refine technical needs/gaps identified during roundtable

Next Steps

- Document technical needs/gaps in a roadmap
- Develop plan for engaging technical and stakeholder communities in development of resilience metrics
  - Building systems
  - Infrastructure systems

Questions?