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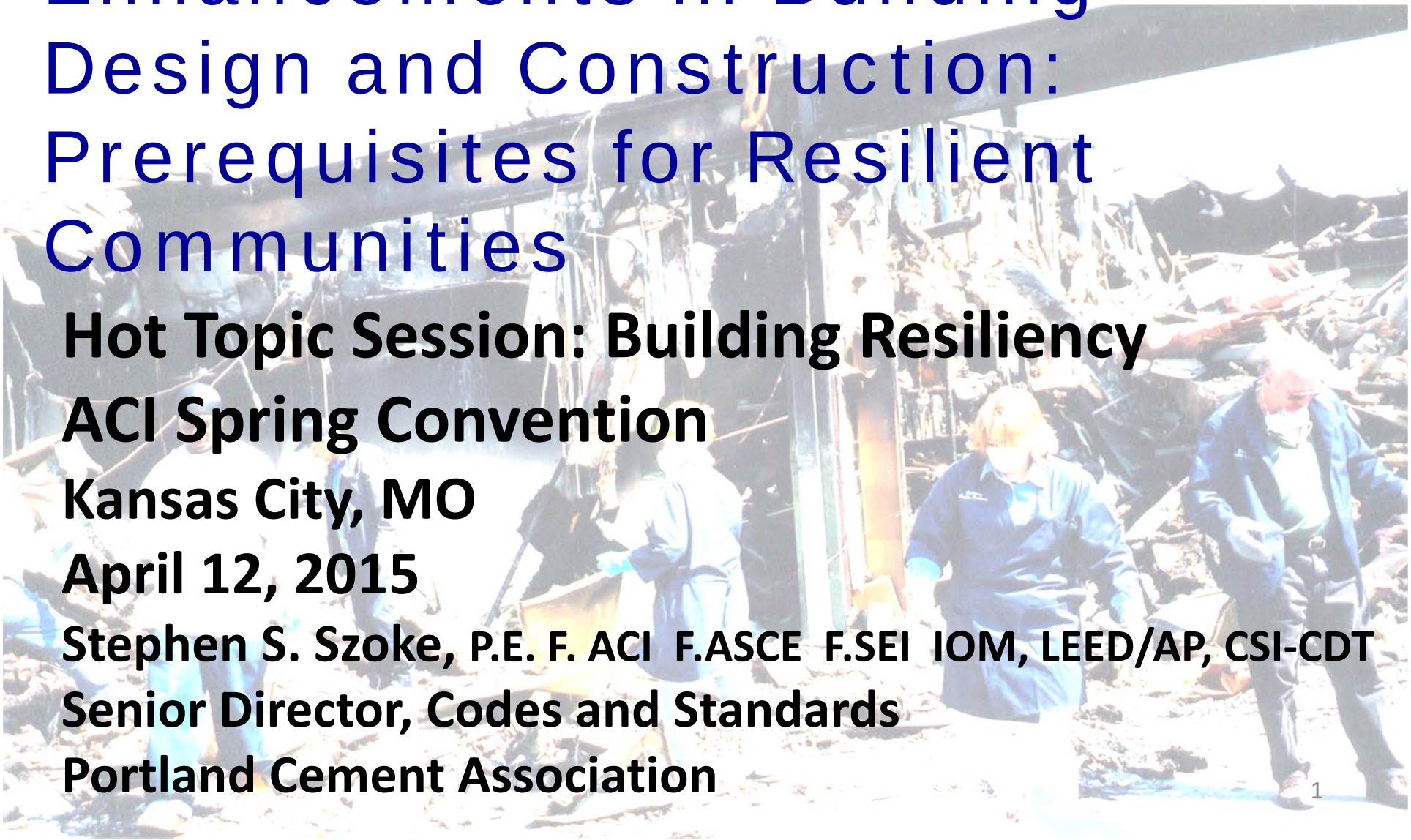
Enhancements in Building Design and Construction: Prerequisites for Resilient Communities



Hot Topic Session: Building Resiliency

ACI Spring Convention

Kansas City, MO

April 12, 2015

Stephen S. Szoke, P.E. F. ACI F.ASCE F.SEI IOM, LEED/AP, CSI-CDT

Senior Director, Codes and Standards

Portland Cement Association

Part 1: Disasters and Property Losses

NOAA, FEMA, Census Bureau, and Insurance Industry Statistics and Data

Part 2: Influencing Factors
Demographics, Construction Volume and Practices

Part 3: Community Resilience
Opportunities: Voluntary or Mandatory Programs

Part 4: Code Modifications
Overview of Criteria for Enhanced Resiliency

Part 5: Call to Action
Better Rules and Regulations – Built Back Better

DISASTER RESISTANCE

Earthquake

Flood

Snow and Ice

Wind

DISASTER RESISTANCE

Wildland Fires

Structure Fires

Conflagrations

FIRES AFTER DISASTERS

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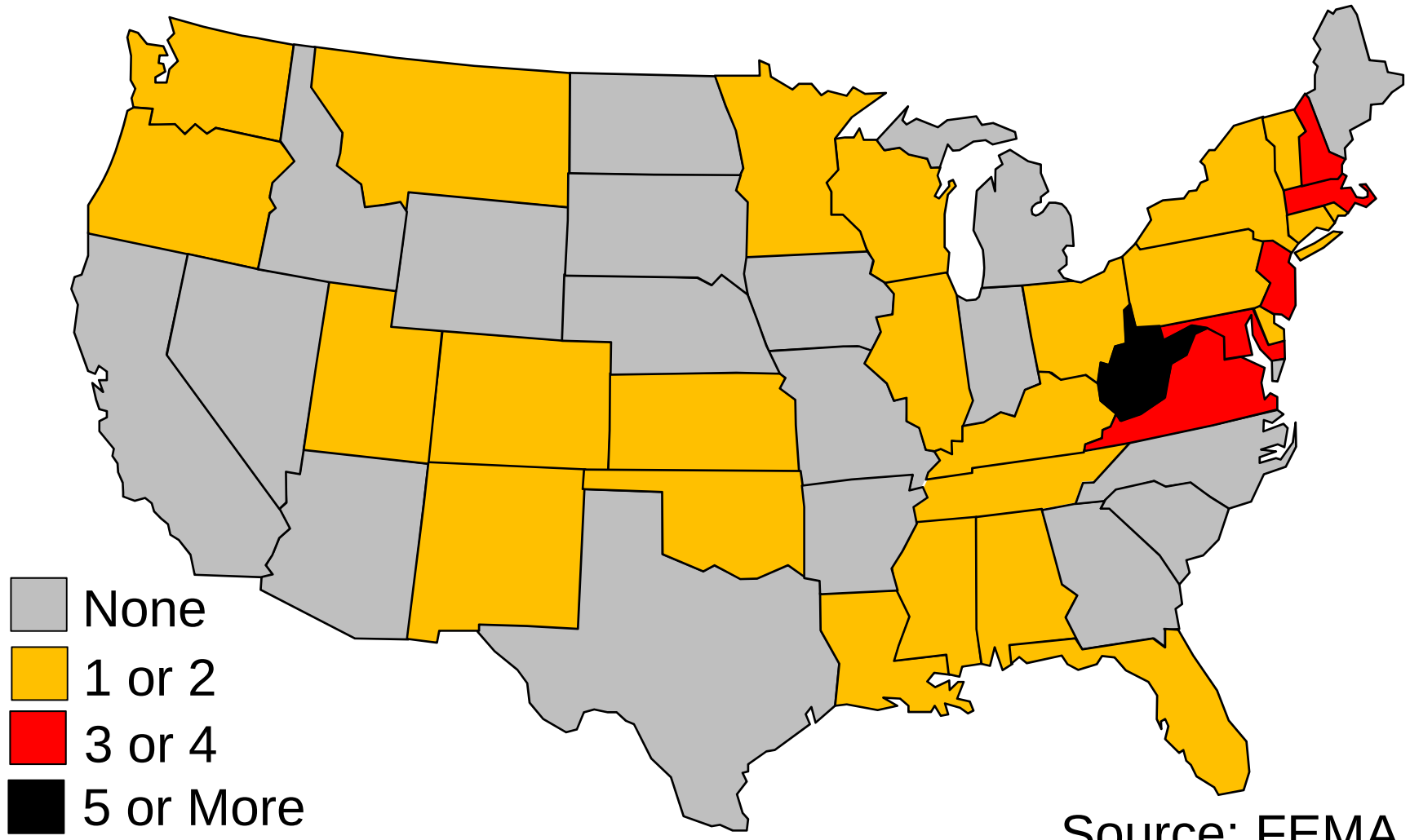
2012 National Disasters and Emergencies



Source: FEMA.gov

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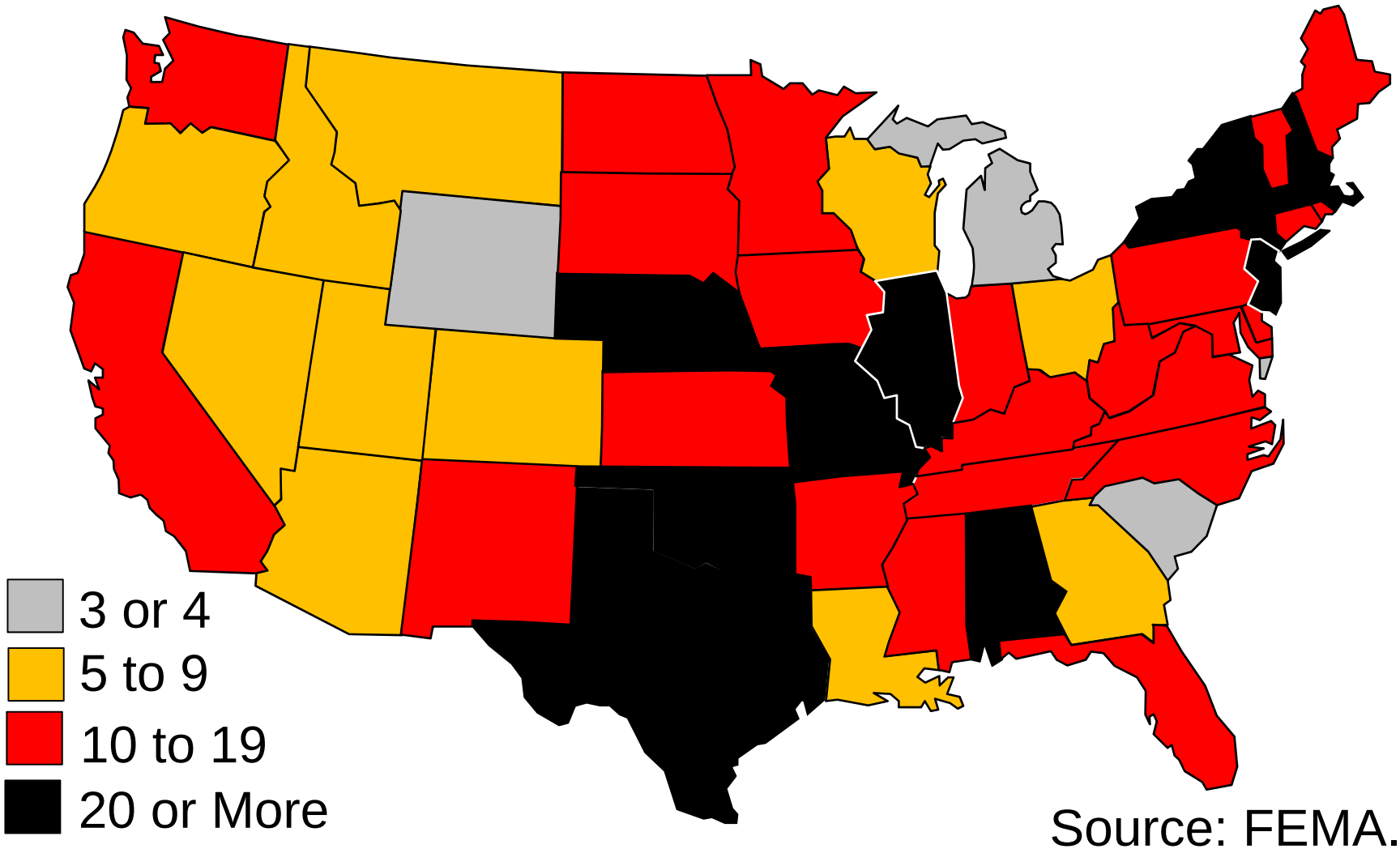
03-12 National Disasters and Emergencies



Source: FEMA.gov

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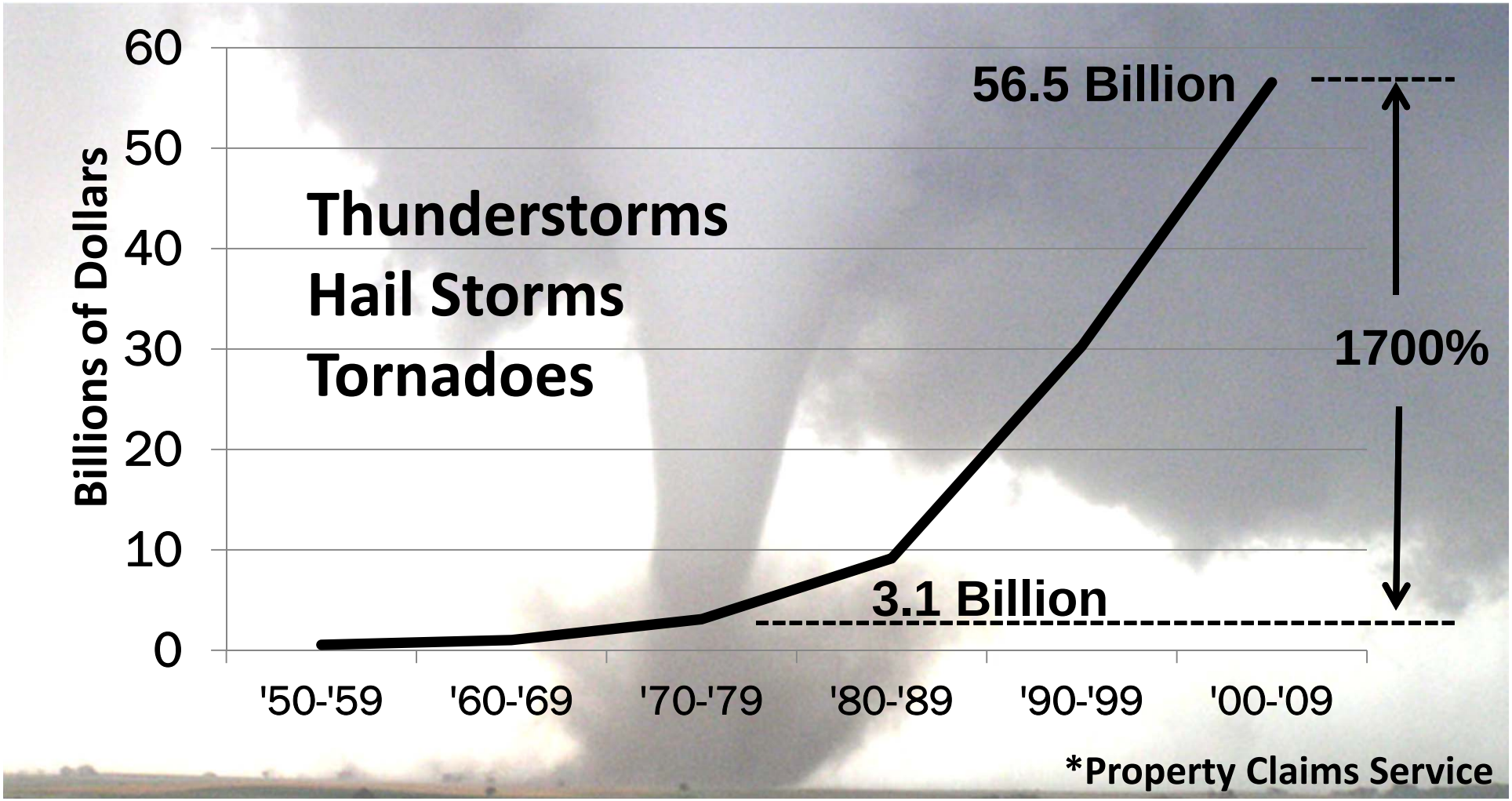
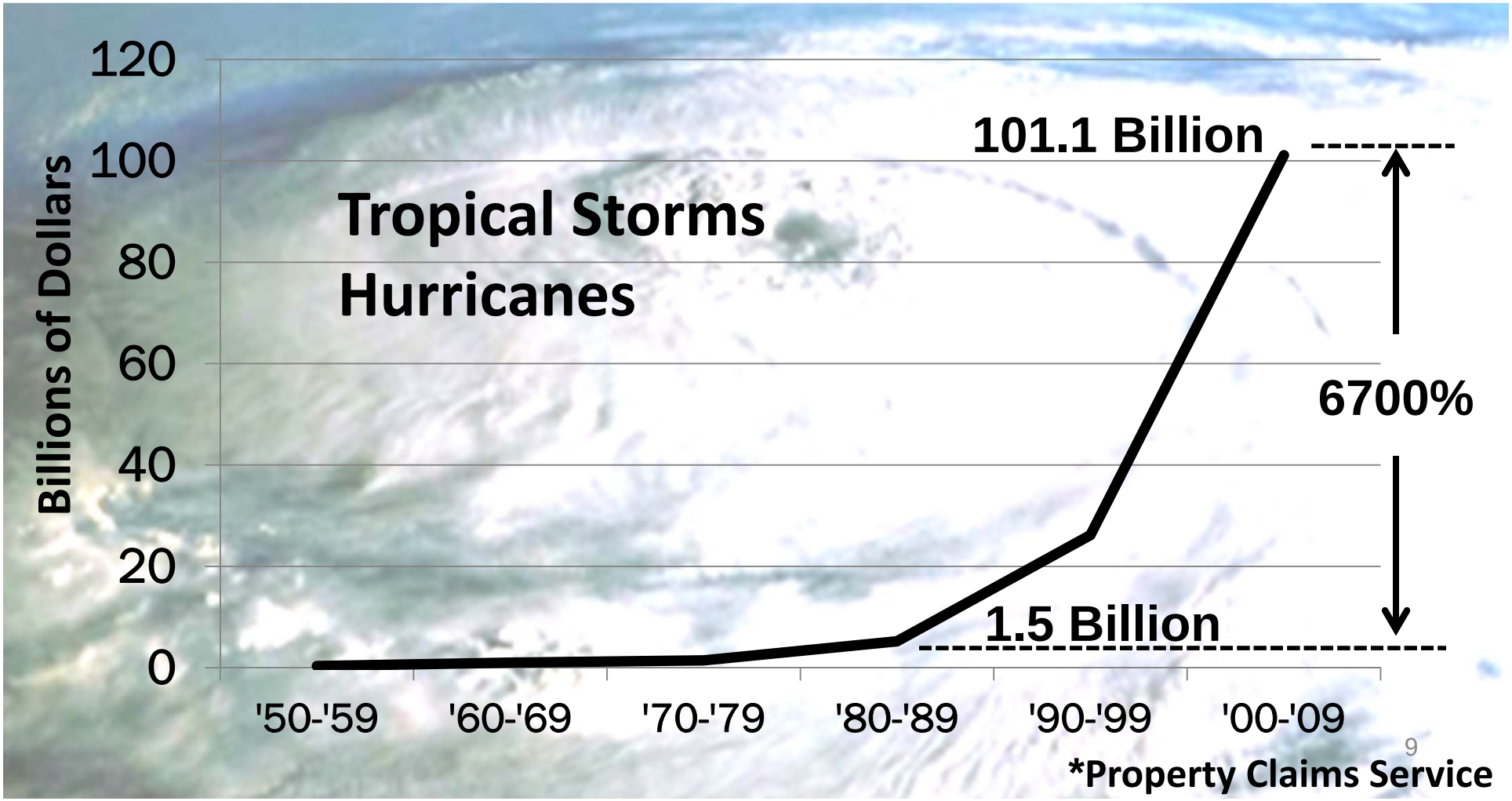
Combined Losses: Tornadoes and Storms

In Billions of 2010 Dollars per Decade*



COMBINED LOSSES: HURRICANES AND STORMS

In Billions of 2010 Dollars per Decade*



*Property Claims Service

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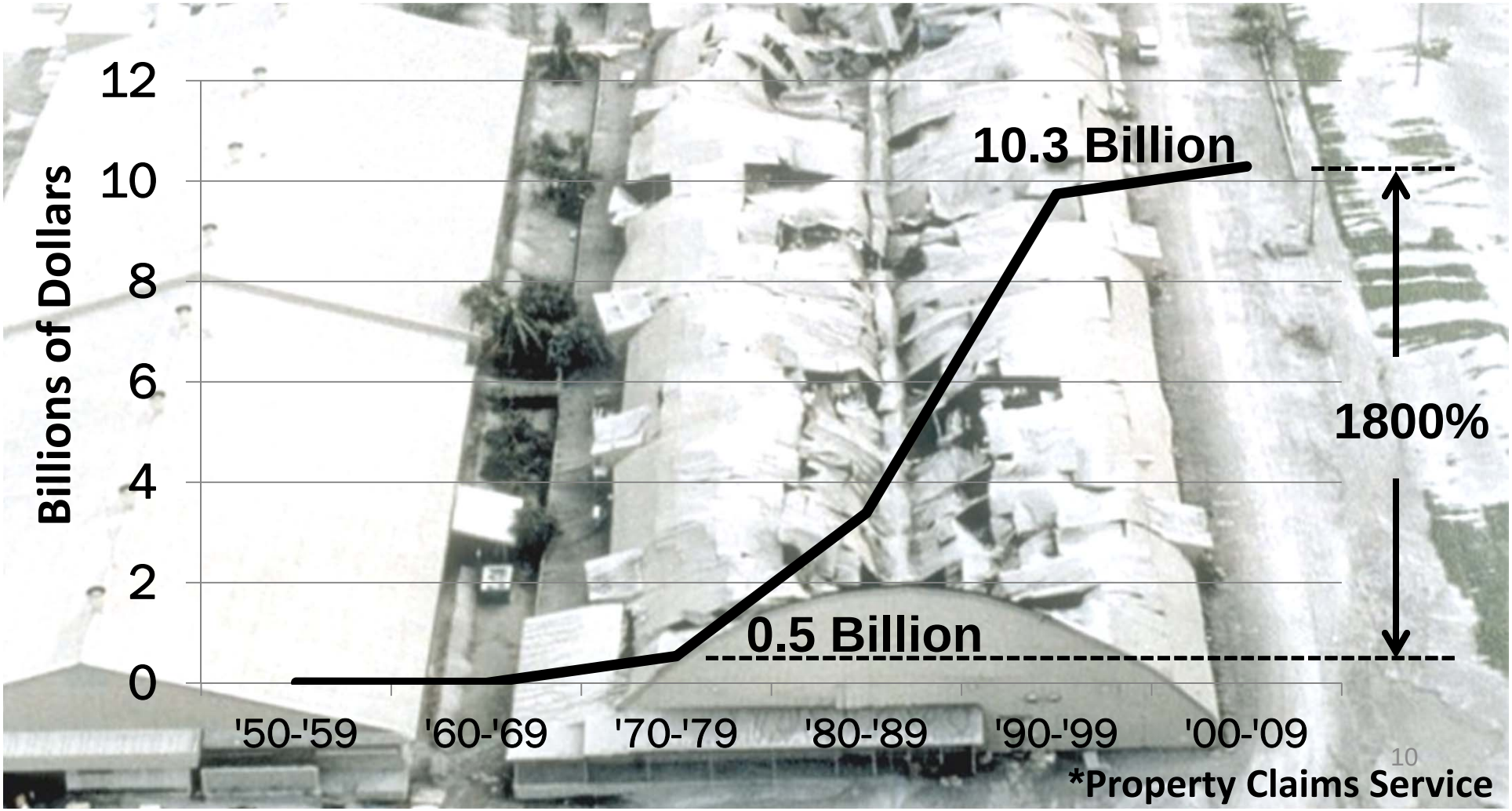
WINTER WEATHER EVENT LOSSES

In Billions of 2010 Dollars per Decade*



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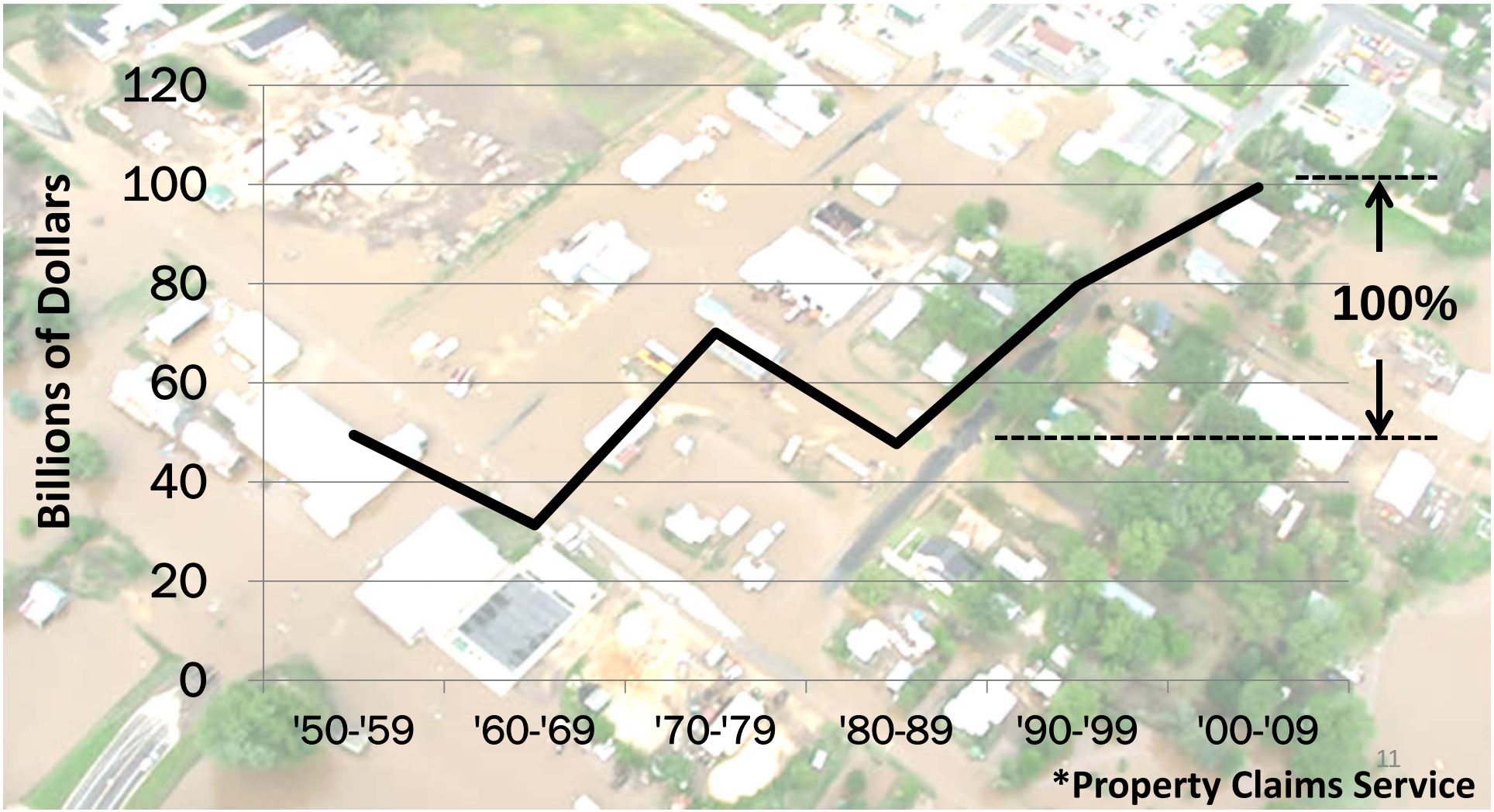
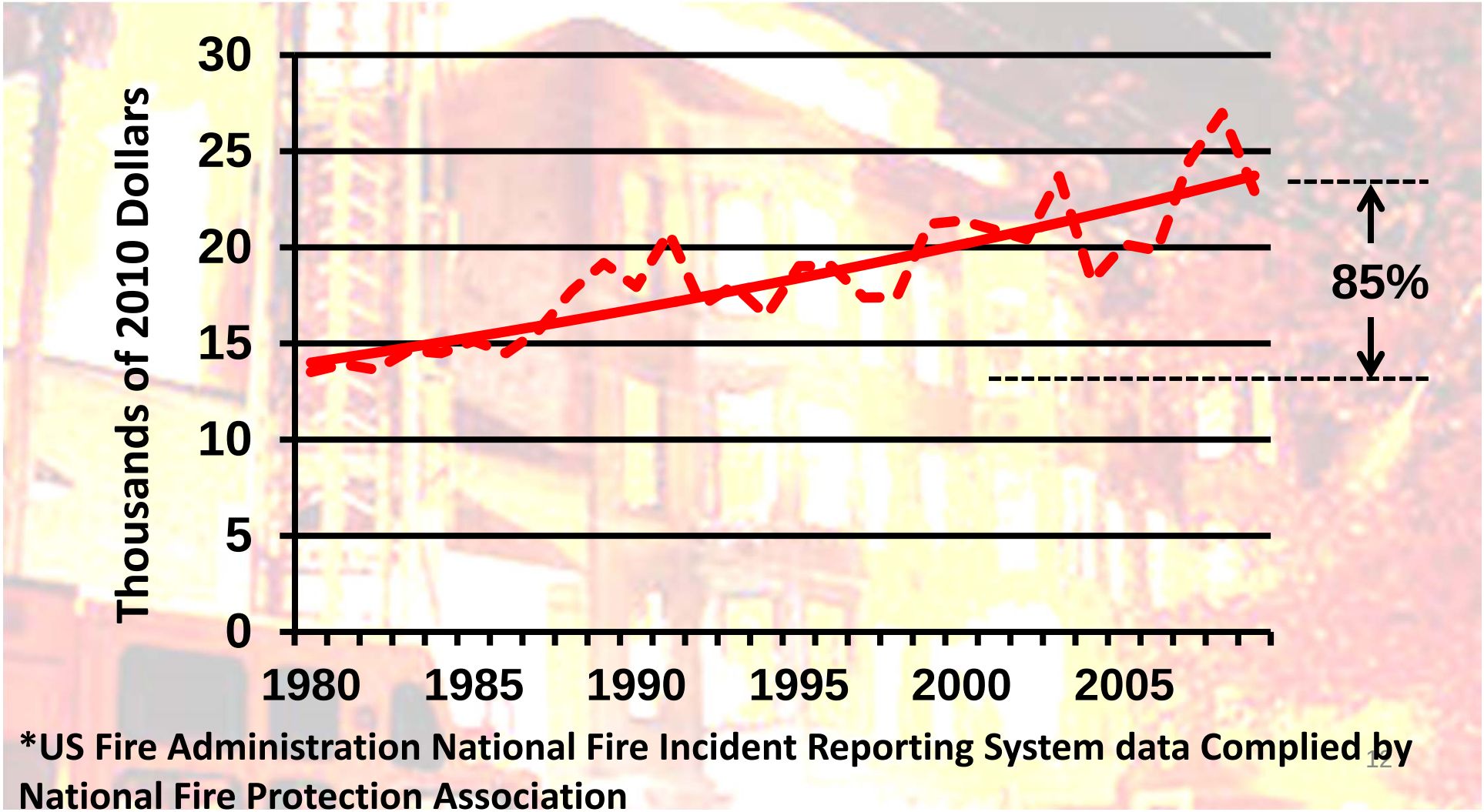
FLOOD LOSSES

In Billions of 2010 Dollars per Decade*



FIRE LOSSES

In Thousands of 2010 Dollars per Fire



*US Fire Administration National Fire Incident Reporting System data Complied by National Fire Protection Association

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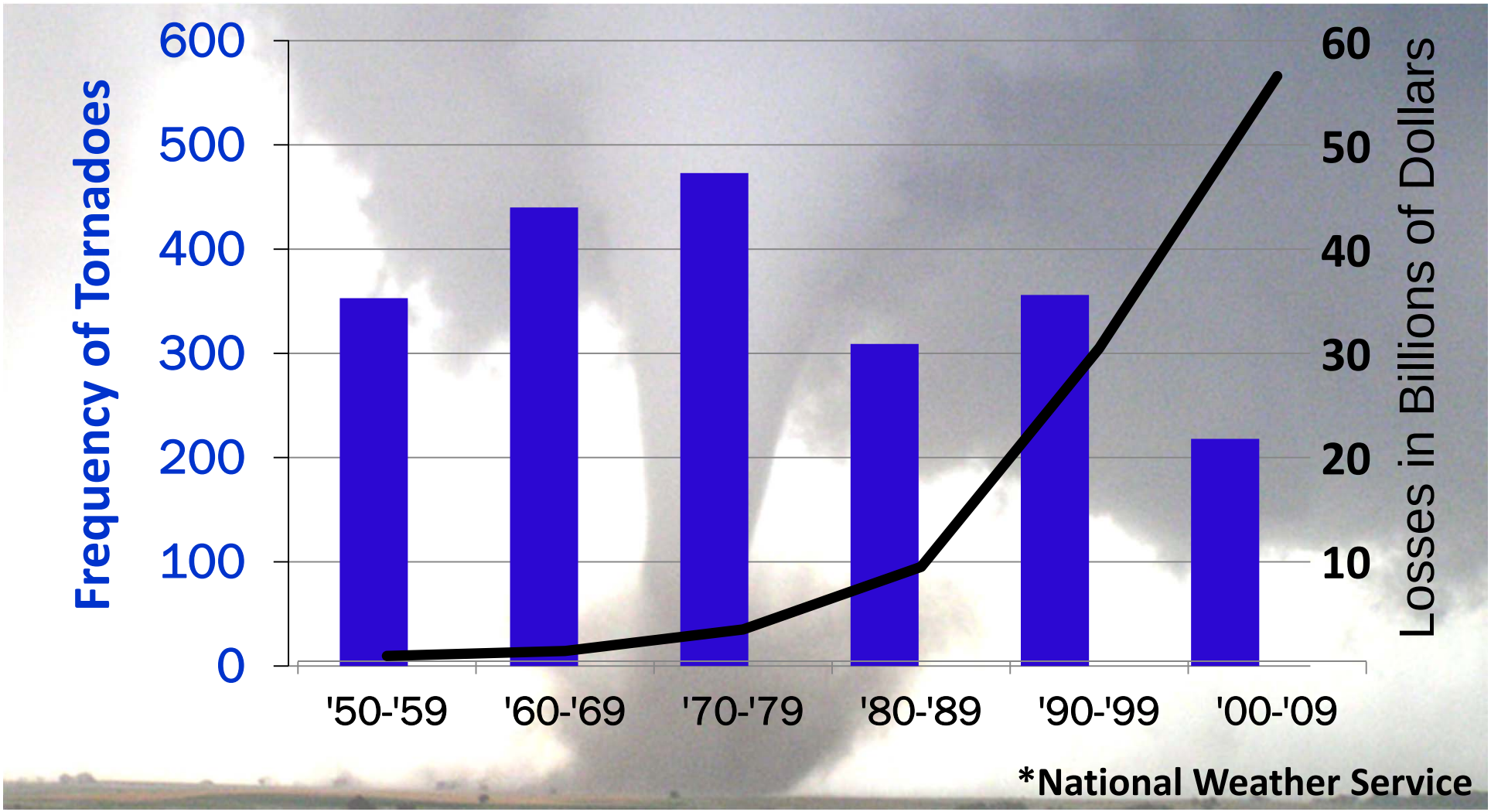
TORNADO LOSSES

Versus Number EF3 –EF5 Tornadoes*



*National Weather Service

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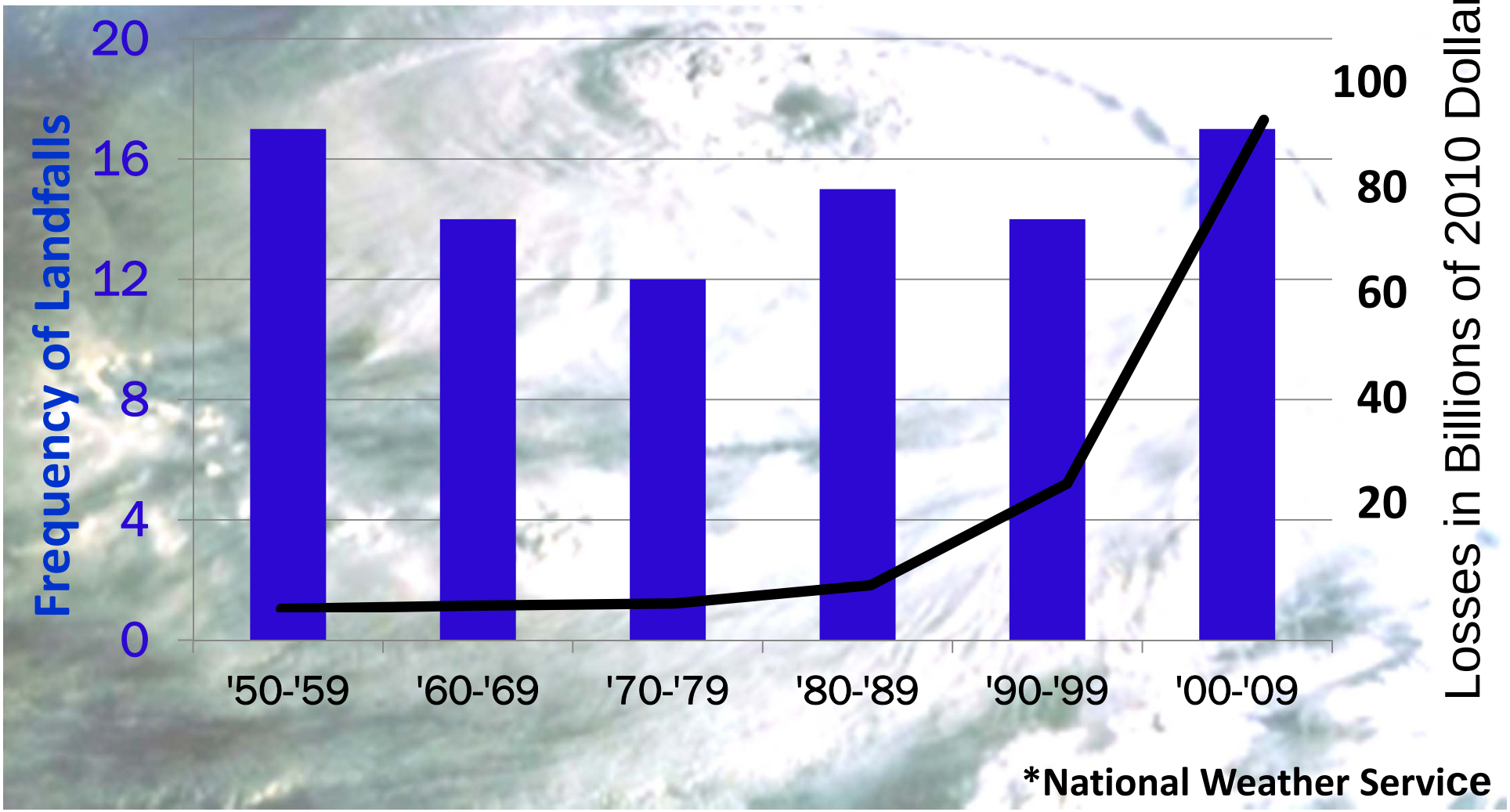
HURRICANES AND TROPICAL STORMS LOSSES

Versus Number of Strikes*



*National Weather Service

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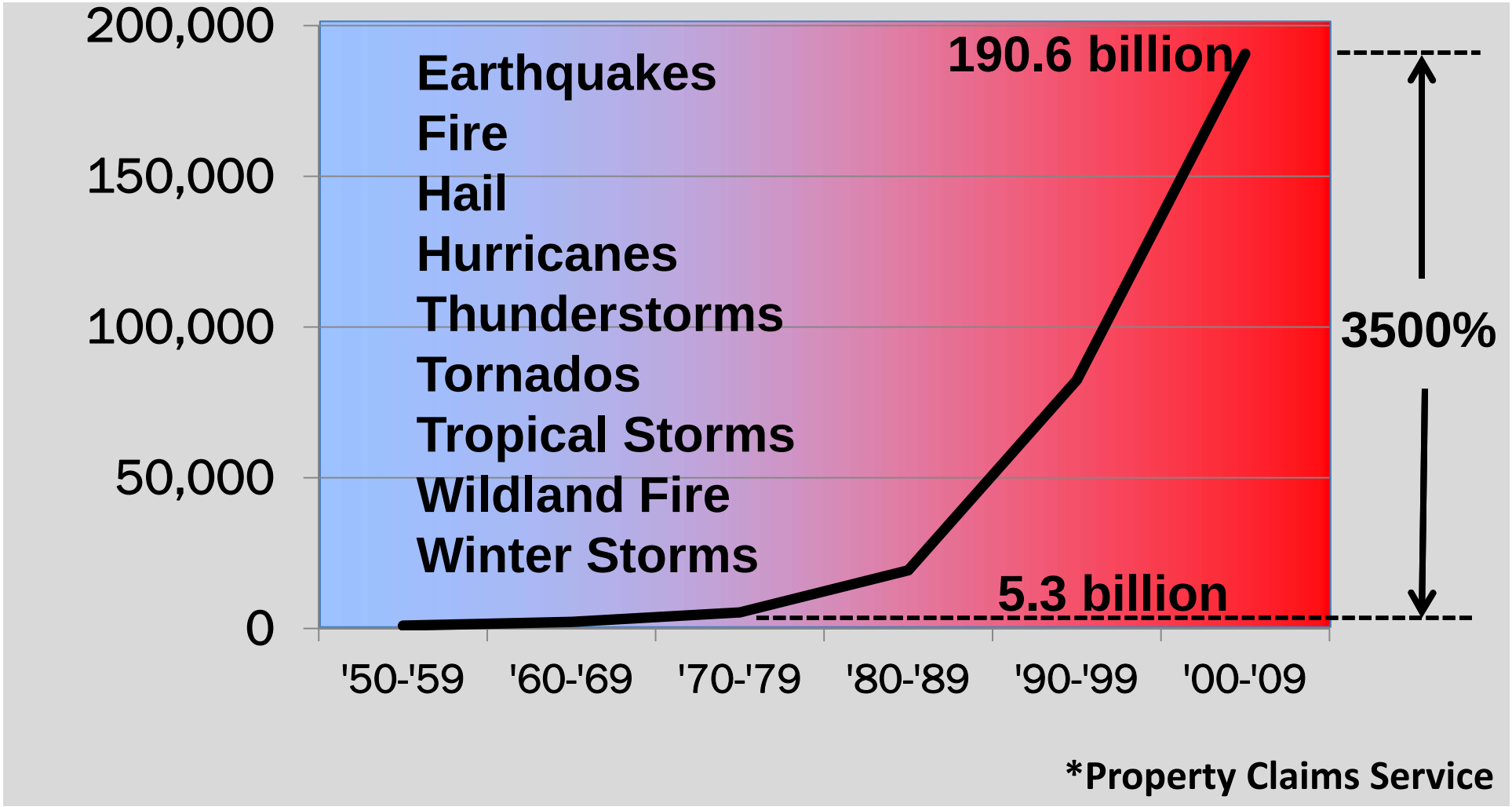
DISASTER LOSSES EXCLUDING FLOOD*

In Millions of 2010 Dollars per Decade



*Property Claims Service

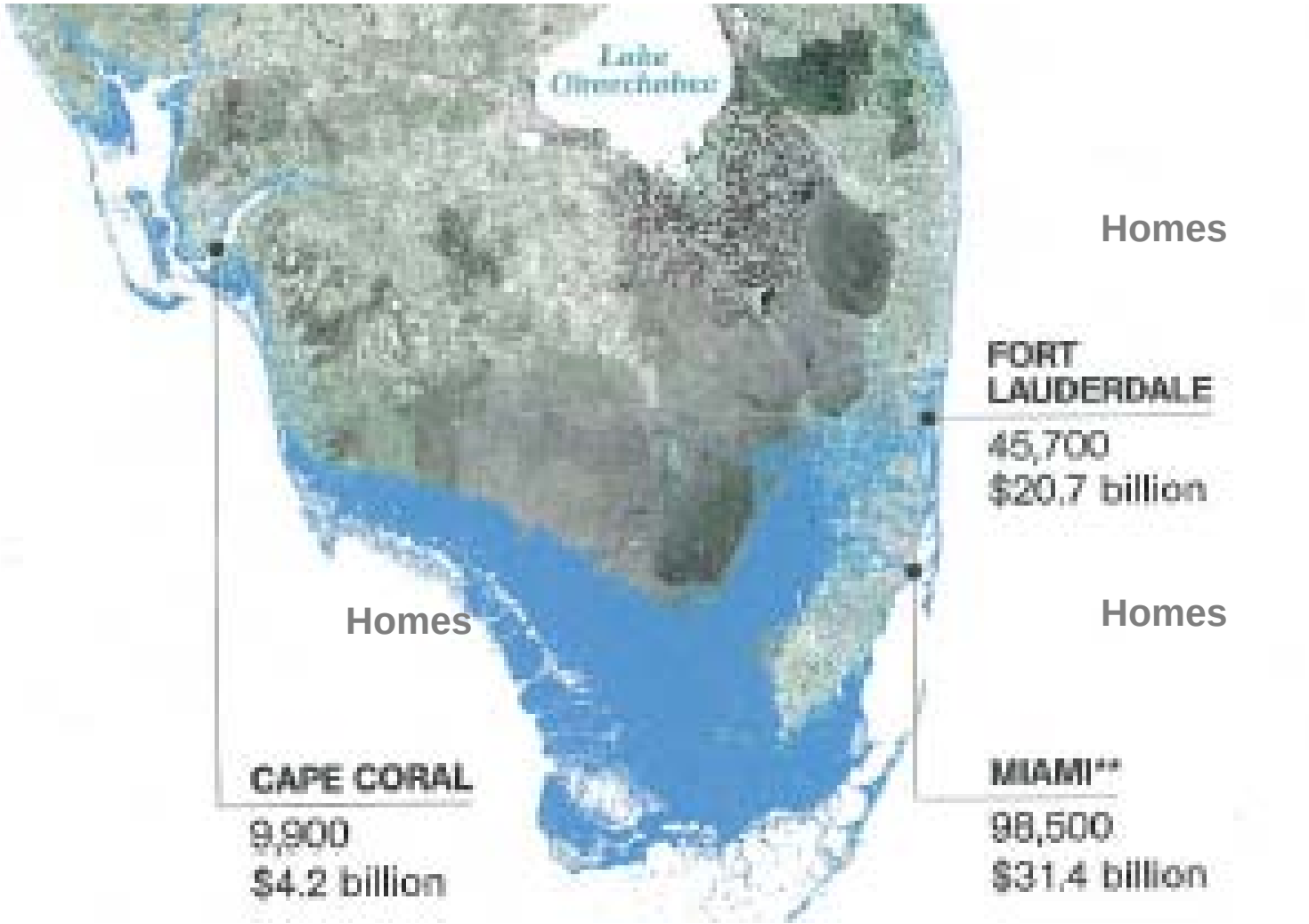
CLIMATE CHANGE

Taken as a whole, the range of public evidence indicates that the net damage costs of climate change are likely to be significant and increase over time

IPCC
INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE

WMO UNEP

SEA LEVEL BY 2100



Source: February 2015 National Geographic

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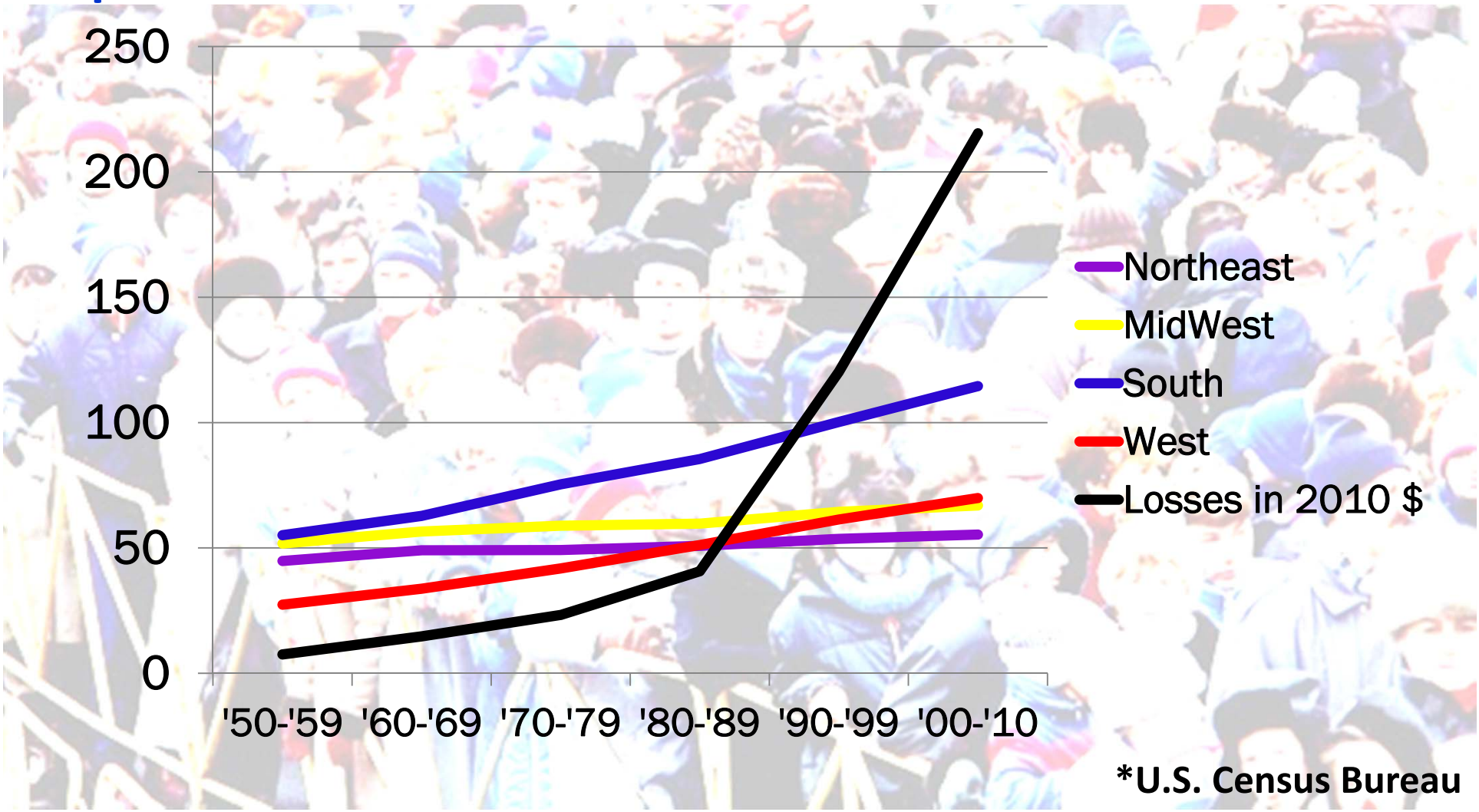
DISASTER LOSSES VS. POPULATION CHANGE*

Population in Millions and Losses in Billions of 2010 Dollars



*U.S. Census Bureau

TYPES OF CONSTRUCTION

Type IA
Type IB
Type IIA
Type IIB
Type IIIA
Type IIIB
Type IV
Type VA
Type VB

TYPES OF CONSTRUCTION

Type	Fire Resistance Rating of Elements – Hours				
	Structural Frame	Bearing Walls		Floors	Roof
		Exterior	Interior		
IA	3	3	3	2	1-1/2
IB	2	2	2	2	1
IIA	1	1	1	1	1
IIB	0	0	0	0	0
IIIA	1	2	1	1	1
IIIB	0	2	0	0	0
IV	HT	2	1/HT	HT	HT
VA	1	1	1	1	1
VB	0	0	0	0	0

HEIGHTS [STORIES] AND AREAS [1000 SQ FT]

Occupancy and Use	Type I		Type II		Type III		IV	Type V	
	A	B	A	B	A	B	HT	A	B
R-1	UL	12	5	5	5	5	5	4	3
Hotels/Motels	UL	UL	72	48	72	48	61.5	48	21
R-2	UL	12	5	5	5	5	5	4	3
Apartments/Dormitories	UL	UL	72	48	72	48	61.5	48	21
R-3	UL	12	5	5	5	5	5	4	4
Boarding Houses	UL	UL	UL	UL	UL	UL	UL	UL	UL
R-4	UL	12	5	5	5	5	5	4	3
Custodial Care	UL	UL	72	48	72	48	61.5	48	21

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Occupancy and Use	Type I		Type II		Type III		IV	Type V	
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	UL	UL	72	48	72	48	61.5	48	21
R-2 Apartments/Dormitories	UL	12	5	5	5	5	5	4	3
	UL	UL	72	48	72	48	61.5	48	21
R-3 Boarding Houses	UL	12	5	5	5	5	5	4	3
	UL	UL	UL	UL	UL	UL	UL	UL	UL
R-4 Custodial Care	UL	12	5	5	5	5	5	4	3
	UL	UL	72	48	72	48	61.5	48	21

Concrete or Steel Frame

Masonry, ICF, Steel Studs

Masonry, ICF, CLT, Steel Studs, FRTW Studs

Heavy Timber and CLT

Conventional Wood Studs

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R-3 Boarding Houses	UL	12	5	5	5	5	5	4	3
	UL	UL	UL	UL	UL	UL	UL	UL	UL
R-4 Custodial Care	UL	12	5	5	5	5	5	4	3
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Concrete or Steel Frame

Masonry, ICF, Steel Studs

Masonry, ICF, CLT, Steel Studs, FRTW Studs

Heavy Timber and CLT

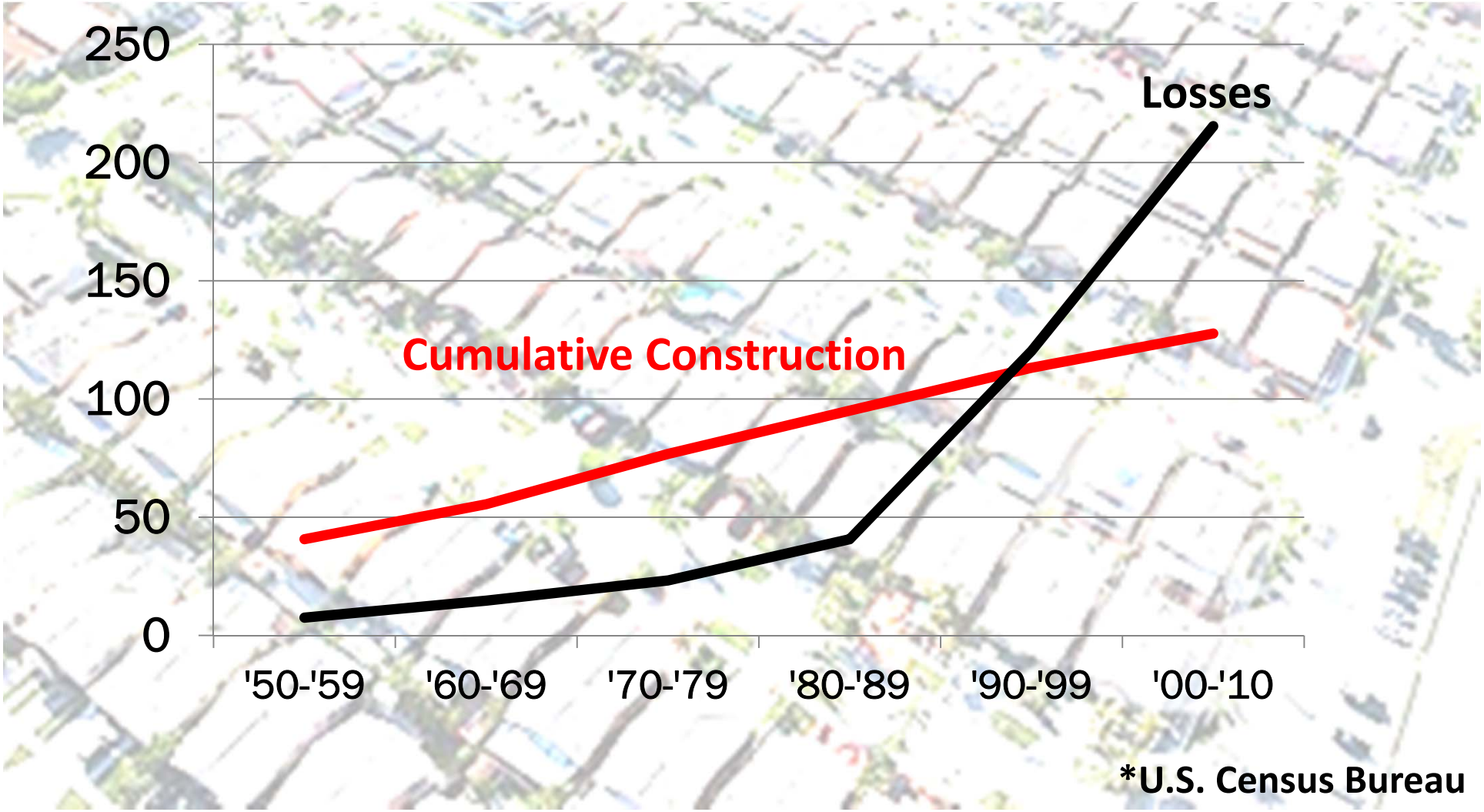
Conventional Wood Studds

TYPE I AND II HIGH-RISES

Replace Type V Low-Rise

Losses vs. Residential Units*

Residential Units in Millions and Losses in Billions of Dollars



*U.S. Census Bureau

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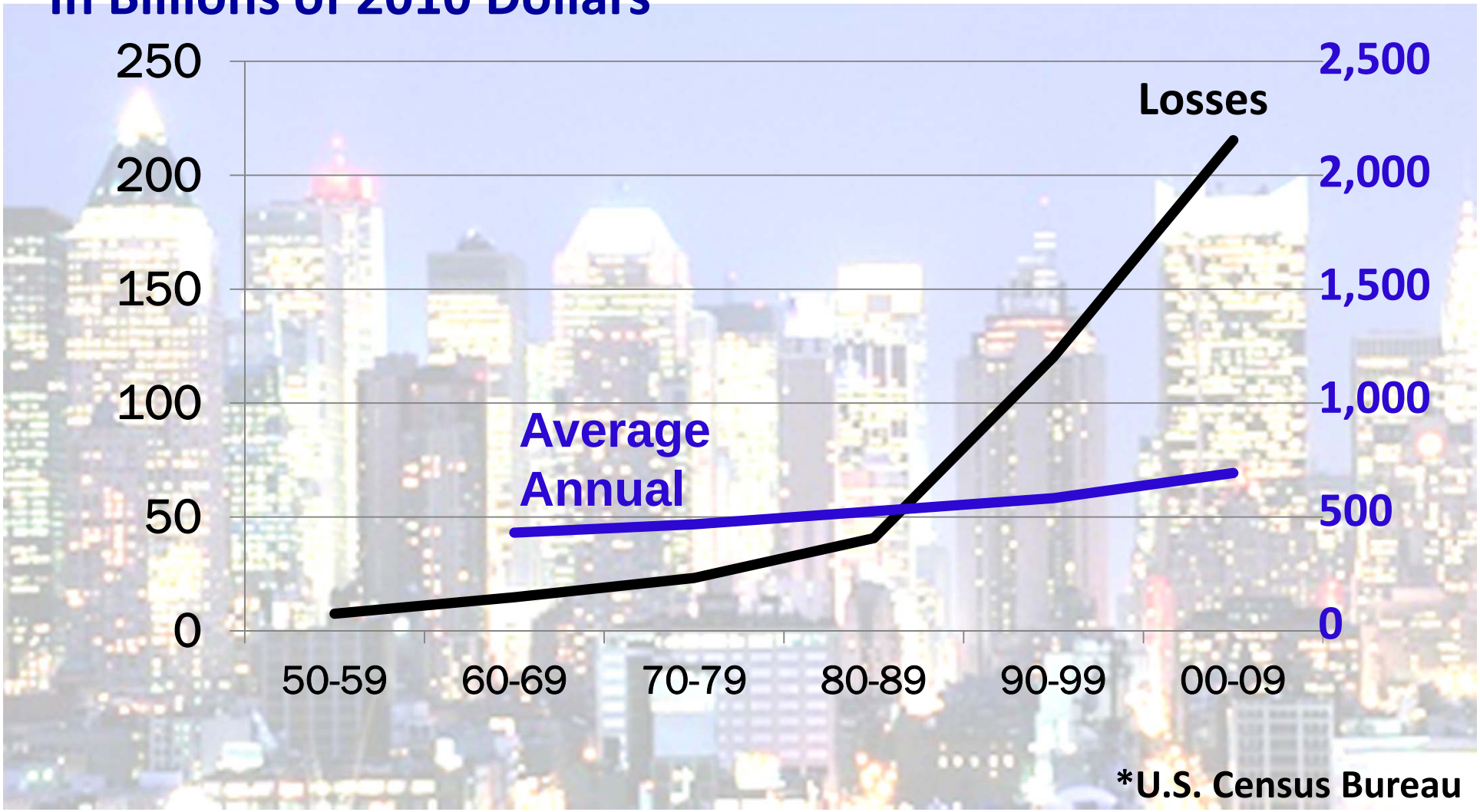
LOSSES VS. COMMERCIAL PUT-IN-PLACE*

In Billions of 2010 Dollars



*U.S. Census Bureau

COINCIDENCE?

- **Frequency of Events**
- **Population Re-Distribution**
- **Amount of Construction**

Where's the Bar Now?

- Societal and Cultural Trends
  - Least Initial Cost/Maximum Return on Investment
  - Increased Political Pressure
  - Emotion Versus Technical Substantiation
  - Acceptance of Disposable Products
- Changes in Construction Practice
  - Move to Lighter/Less Expensive Construction
  - Project Management and Value Engineering
- Rules and Regulations

SOCIETAL AND CULTURAL CHANGES

- Maximum Return on Investment
- Competition and Short-Term Ownership
- Political Pressures and Influence
- Economic Development = Revenue
  - Short-Term versus Long-Term Mentality
  - Aging Infrastructure

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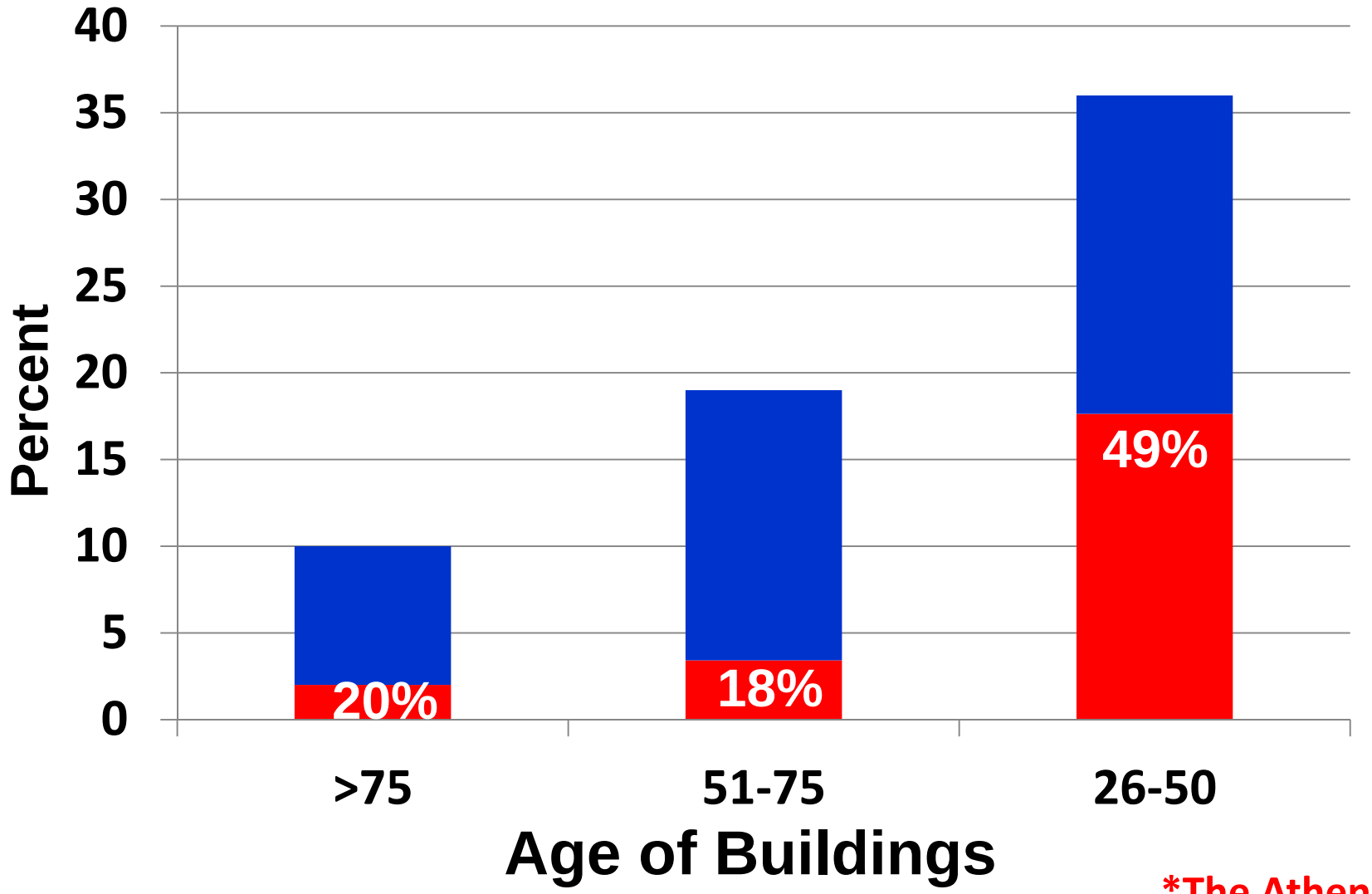
DEMOLITION* VS. ALL BUILDINGS* BY AGE



*The Athena Group

TIMELESS ARCHITECTURE

durable, long-lasting materials and systems

ENHANCED RESILIENCE

Winecoff Hotel Built in 1913

Completely gutted by fire in 1946,

Hotel in 1951,

Housing for elderly,

Vacant for 20 years, and

Ellis Hotel in 2007

ENHANCED RESILIENCE – 9/11

Enhanced Resilience: 9/11

90 West St. Built in 1907

- Damaged by WTC collapse,
- Uncontrolled fire for 5 days, and
- Reopened as apartment building in 2005

CHANGES IN CONSTRUCTION PRACTICES

Move to lighter/less expensive construction

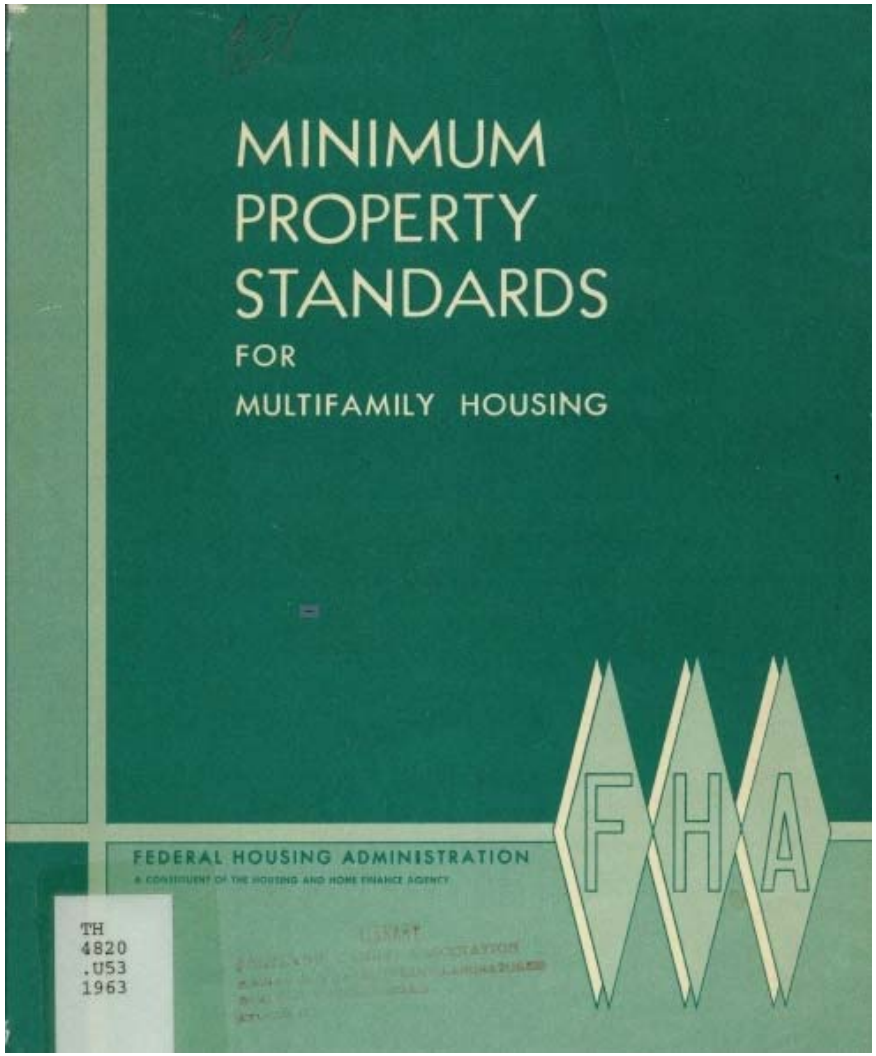
- **Plywood sheathing**
- **Oriented strand board sheathing**
  - **Structurally comparable**
  - **Comparable impact resistance**
- **Foam board sheathing**

CHANGE IN OWNER'S ROLE

Project Management and Value Engineering

De-Regulation

- More stringent passive fire protection
- More stringent sound transmission loss criteria
- Etc…



Relaxation of Model Codes ('70s & '80s)

Height and area tables permitting

larger Type V buildings

Relaxation of Model Codes ('70s & '80s)

Height and area tables permitting larger Type V (wood frame) buildings Avalon Apartments, NJ

Source: 4 NEW YORK

Relaxation of Model Codes ('70s - '80s)

- Sprinkler protection required in more buildings.
- Trade-offs in passive protection and egress safety used to offset sprinkler costs.
- Moving away from prescriptive material specific provisions to performance based requirements.

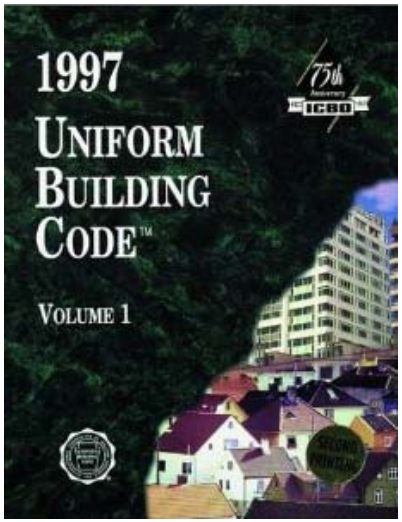
NFPA US Experience with Sprinklers

John R. Hall June 2013

…performance of operating effectively in 87% of all reported fires where sprinklers were present in the fire area and fire was large enough to activate them.

Relaxation of Model Codes ('97-'00s)

- **The merger resulted in the least common denominator for passive fire protection.**
- **Most aggressive trade-offs for sprinklers were also included from any one code.**



CULTURAL/SOCIETAL CHANGE:
Increased Competition and Increased Emphasis on ROI

- Least initial cost is minimum building code or less
- Minimum building code is becoming the standard of practice in the United States
- Design firms advertising alternative compliance to lower initial costs

TREND SUGGESTS THAT THE PROBLEM OF AGING BUILDINGS WILL BECOME GREATER IN THE FUTURE IF WE DO NOT IMPROVE THE WAY BE BUILD NEW BUILDINGS TODAY.

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Elevated National Priority

- Presidential Policy Directives
- Presidential Executive Orders
- Proposed Federal Legislation
- DHS National Resilience Roadmap
- DHS Resilient Star
- NIST National Resilience Framework

POLITICAL VIEWS

- December 2, 2014 – Congressman Daniel Webster, D-FL:

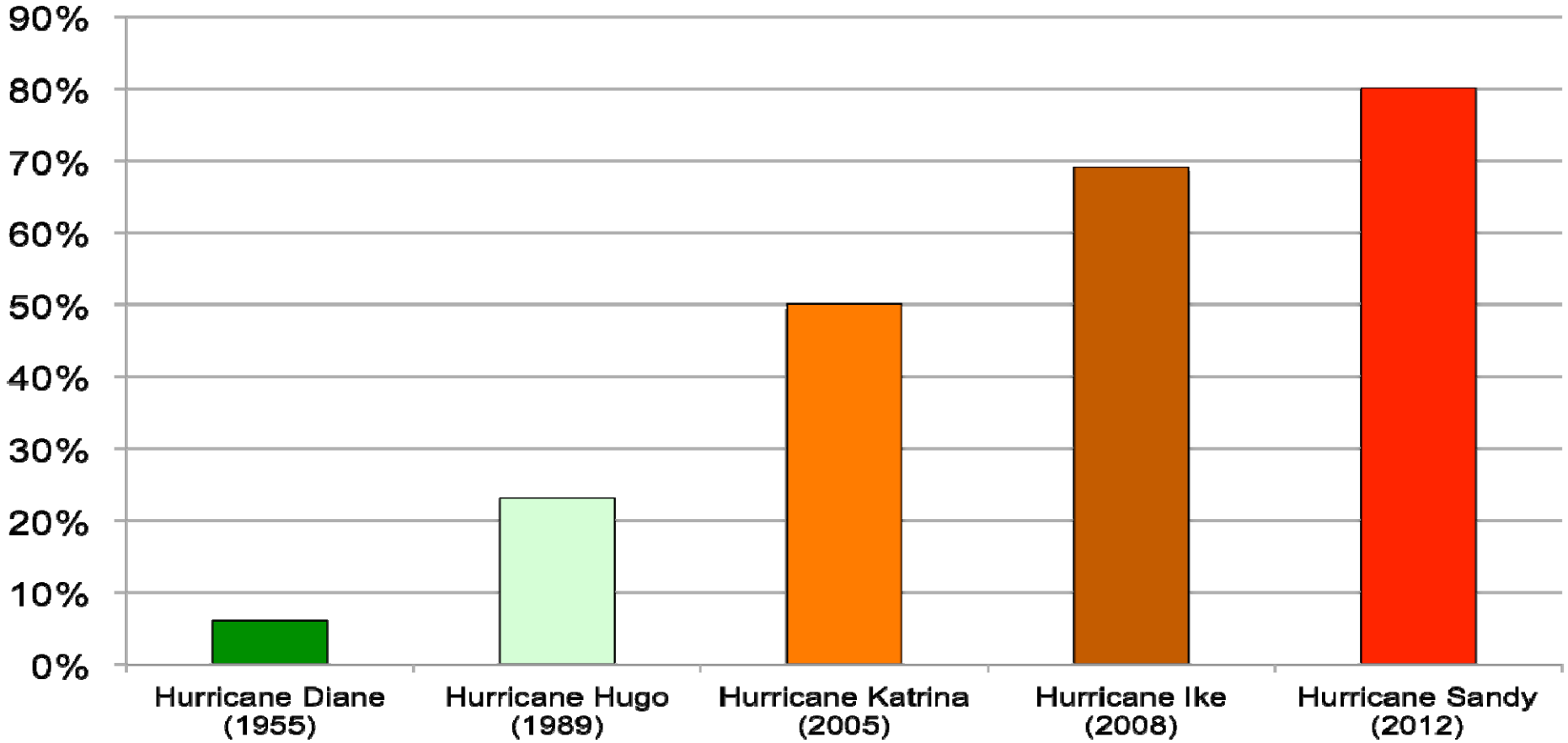
  "Buildings should not fall down during a hurricane or any other disaster."

- November 22, 2014 – Moore, OK Officials

  "We can't have our primary focus on 'affordability' anymore."

ROLE OF FEDERAL GOVERNMENT

Portion of total government paid losses

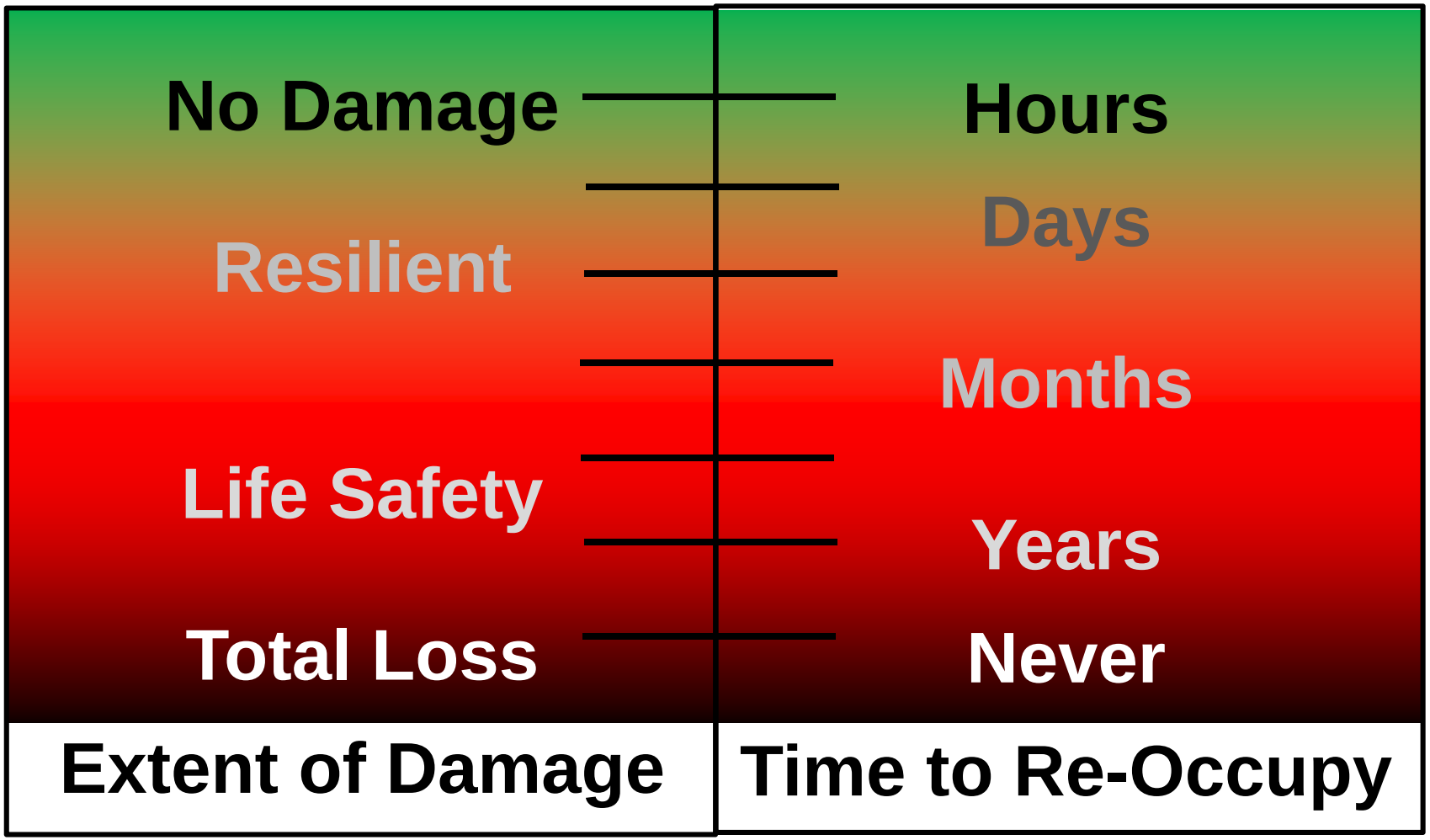


Sources: E. Michel-Kerjan. *Have We Entered an Ever-Growing Cycle on Government Disaster Relief?* - Testimony before the U.S. Senate (2013).

KEY ATTRIBUTES OF ENHANCED RESILIENCE

- Increased Resistance to Disasters
- Increased Longevity
- Increased Robustness
- Improved Sustainability
- Improved Life Safety
- Increased Durability
- Increased Adaptability for Reuse

Enhanced Resilience vs. Life Safety



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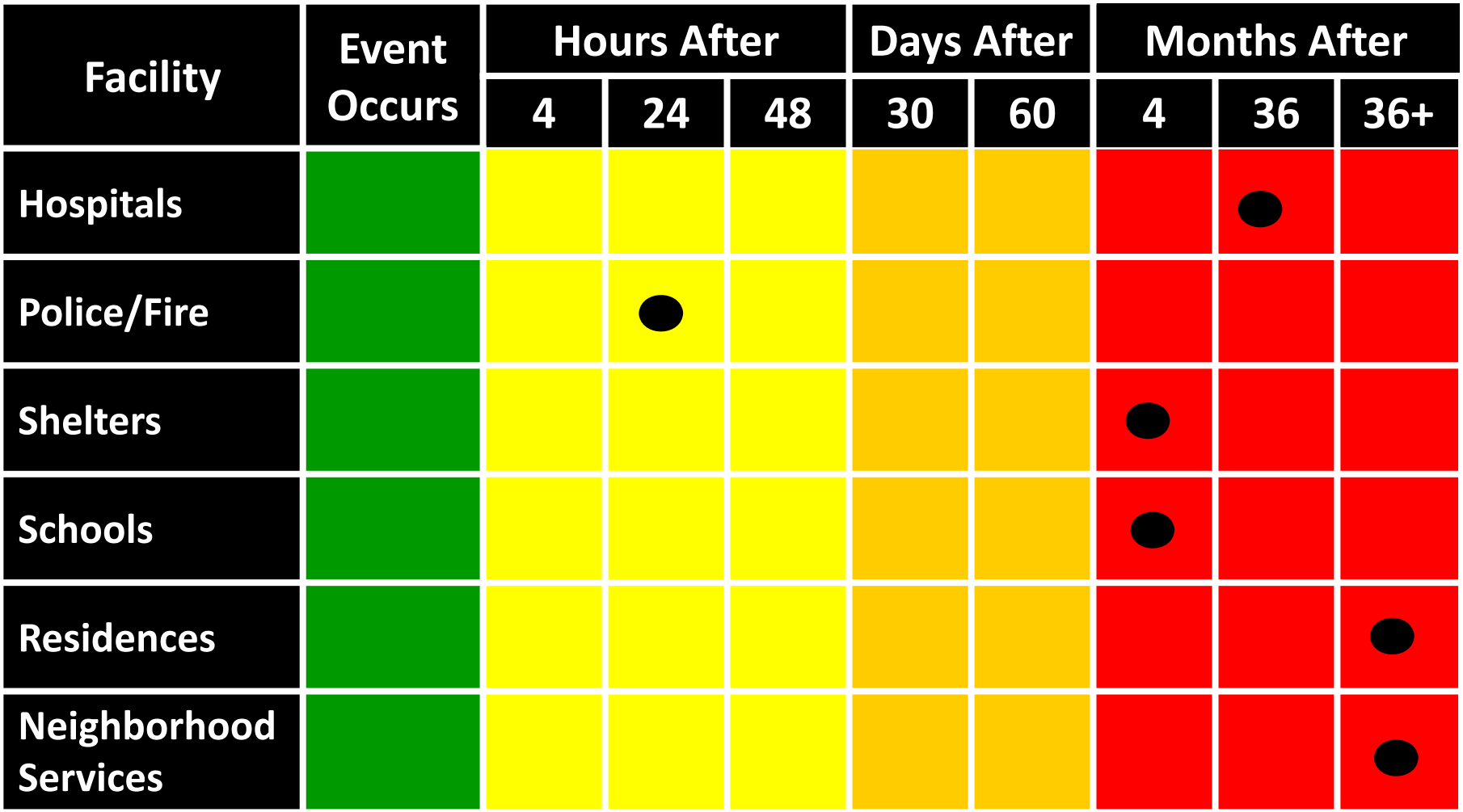
San Francisco Target Recovery (SPUR)



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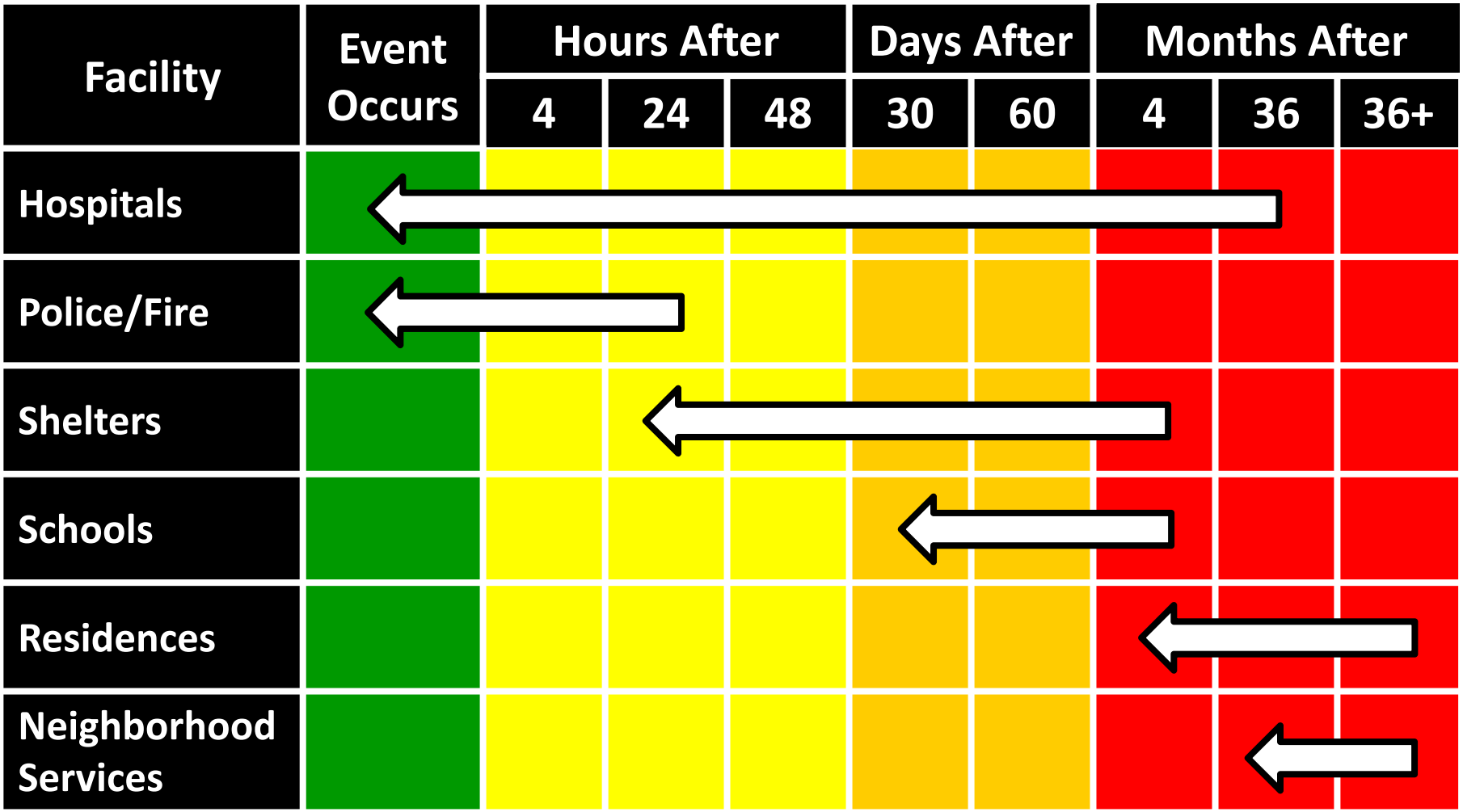
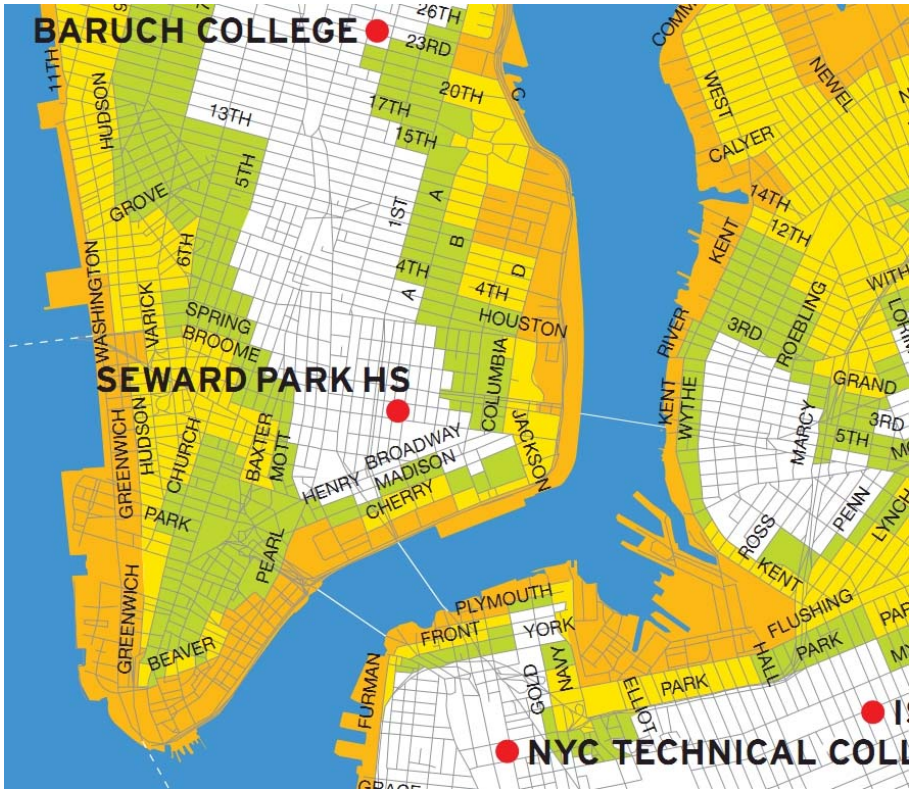


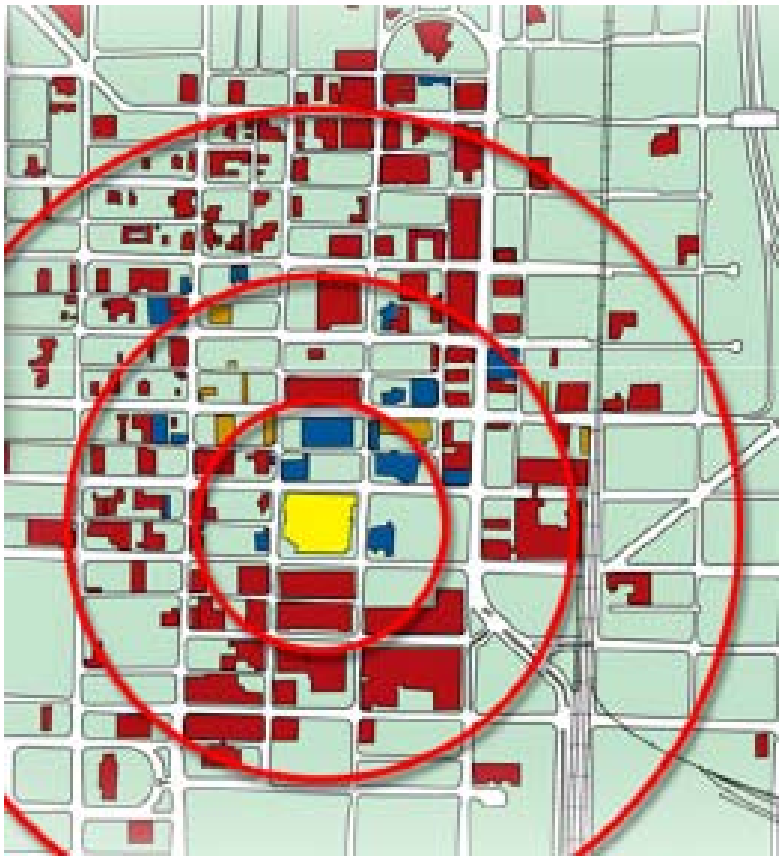
GETTING OPERATIONAL

Time Frame	Hospitals	Fire/ Police	Shelters	Schools	Homes	Services
Immediately	90%	100%				
24 Hours	5%		95%	90%	75%	75%
48 Hours	3%		5%	5%	3%	3%
30 Days	2%			5%	2%	2%
4 Months					6%	9%
36 Months					4%	6%
Longer or Never					10%	5%

Risk Assessment



- Any Hurricane
- Category II
- Category III or IV



- Event
- Structural Damage
- Non-Structural Damage

National Institute of Building Sciences
Sustainable Building Industries Council

Whole Building Design Guidelines

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Institute for Business & Home Safety®

FORTIFIED
... for safer living.®

A program of the Institute for Business & Home Safety

A program of the Institute for Business & Home Safety

DHS Resilience Star

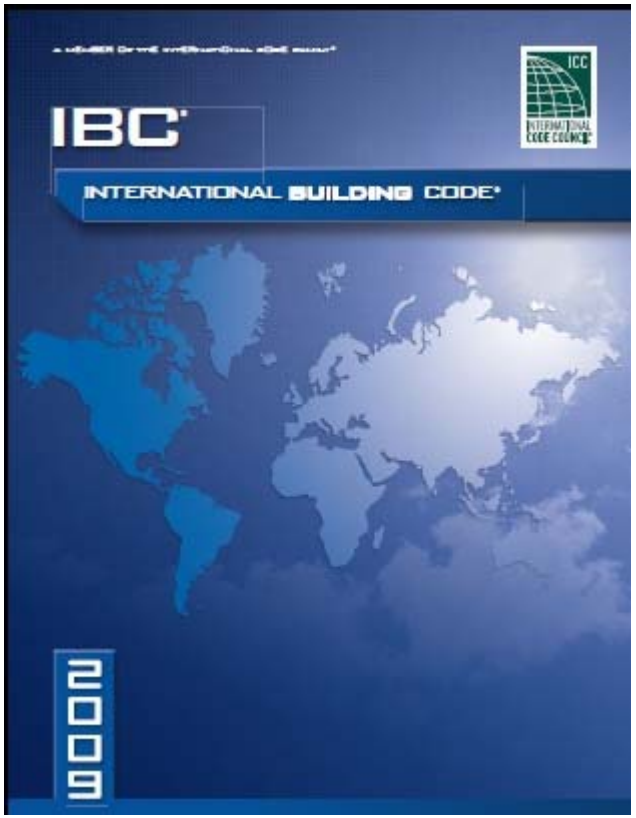
DHS launched the Resilience STAR pilot, a voluntary certification program that aims to make homes and buildings more secure and resilient to all hazards. The RESILIENT Homes Pilot brings DHS together with local officials, private sector insurers and builders, and community leaders in risk-prone communities to rebuild private residences recently destroyed by hazards such as tornados and floods.

VOLUNTARY PROGRAMS

- Knowledge / Understanding of Benefits
- Knowledge / Understanding of Consequences
- Ability / Opportunity to Influence
- Commitment to Overcome Barriers / Resistance
- Financial Resources

ENHANCED RESILIENCE

- **A must for sustainability**
- **Essential for community continuity**



IBC Minimum Code

+ Enhanced Resilience

= Improved Community Resilience, Continuity, and Sustainability

www.cement.org

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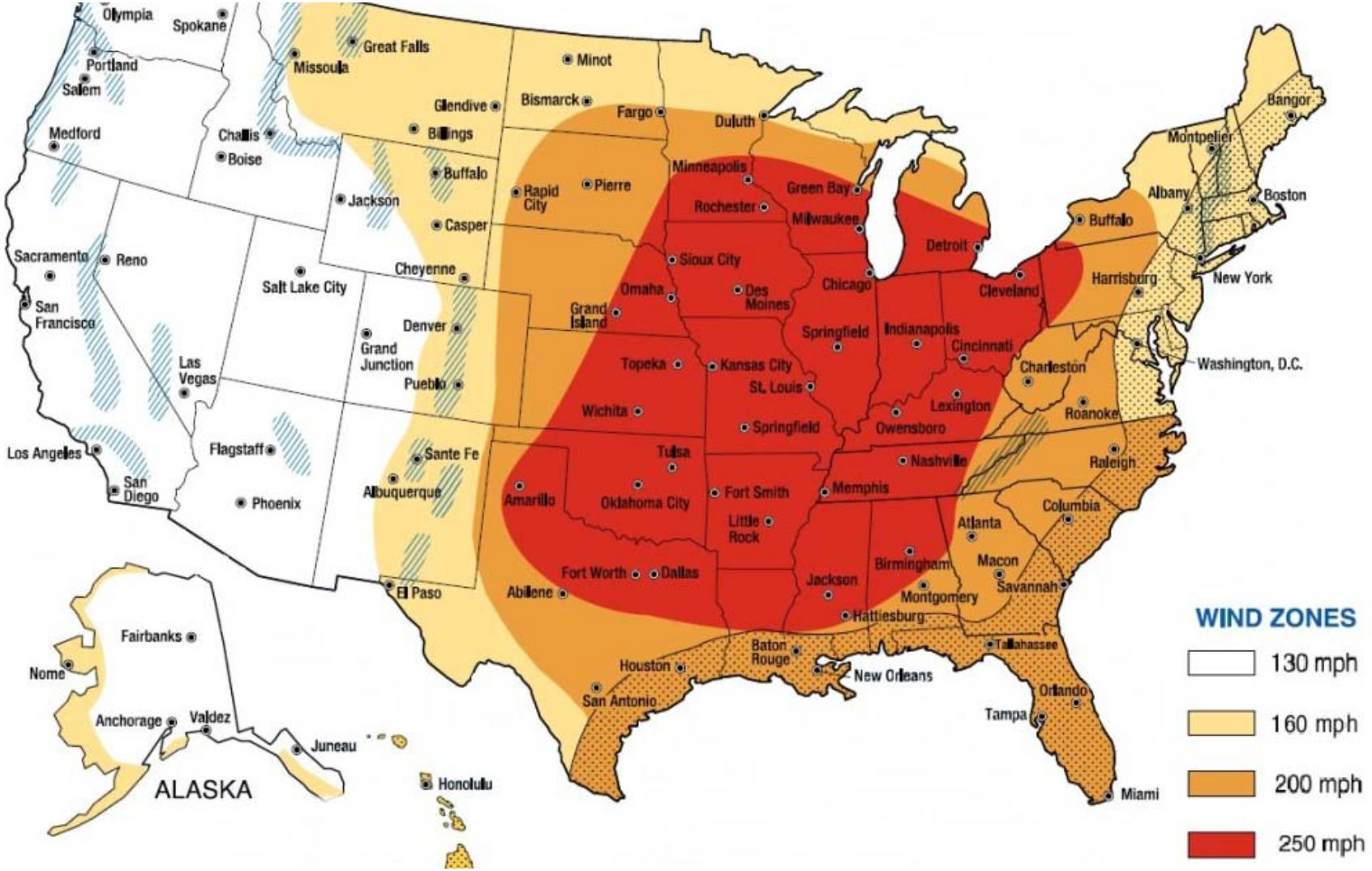
STRUCTURAL COMPONENTS

- **Fire:** Maintain fire resistance ratings of at least one-hour.
- **Flood:** ASCE 24; do not consider levees and flood walls as flood protection; modify coastal zone construction
- **Seismic:** Increase seismic loads in high seismic areas by 10 to 15%.
- **Snow:** Increase design snow loads by 10 to 15%.
- **Storm Shelters:** Require storm shelters in accordance with ICC 500.
- **Wind:** Increase ultimate design wind speed by 10 to 15%.

2015 INTERNAT'L BUILDING CODE - Shelters



FIRE PROTECTION COMPONENTS

- **Automatic Sprinkler Systems:** Use sprinklers systems in all occupancies except low hazard manufacturing and storage facilities and do not use NFPA 13 R automatic sprinkler systems.

- **Internal Fire Barriers:** Maintain minimum 2-hr fire separations and provide draftstopping and fire stopping in concealed spaces.

INTERIOR COMPONENTS

- **Acoustical Comfort:** Require STC ratings of at least 50 for opaque walls and at least 30 for fenestrations and require IIC ratings of at least 50 for floor ceiling assemblies.

- **Moisture Protection:** Protect materials susceptible to moisture damage during construction and provide smooth hard non-absorbent surfaces when water is likely to be present during building operations.

EXTERIOR COMPONENTS

- **Fire:** Limit openings and combustible materials in close proximity to adjacent structures.
- **Wildfire:** Adopt *Wildland-Urban Interface Code*.
- **Wind:** Limit the use of exterior cladding materials susceptible to wind damage to locations outside hurricane and tornado prone areas.
- **Hail:** Limit cladding materials susceptible to hail damage.
- **Rodent proofing:** Mandate Appendix F of the IBC.
- **Radon Entry:** Use EPA *Guide to Radon Prevention* or Appendix F, Radon Control Methods, of the *International Residential Code*.

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STATE AND FEDERAL REGULATIONS

- **Require all government owned, leased, or financially supported (HUD mortgage insurance loans etc.) to:**

  1) Min. follow FEMA guidelines

  or

  2) IBHS plus FEMA guidelines plus passive fire protection

STATE AND LOCAL REGULATIONS

- **Have mandatory provisions that require compliance with IBHS plus FEMA guidelines plus passive fire protection**
  1) **All buildings**
  2) **All government buildings**
  3) **Designated buildings**
- **Have optional provisions that require compliance with IBHS plus FEMA guidelines plus passive fire protection**

ACHIEVING ENHANCED RESILIENCY

Collapse Avoidance = Life Safety

Collapse Avoidance = Minimized Damage

All Other Disasters

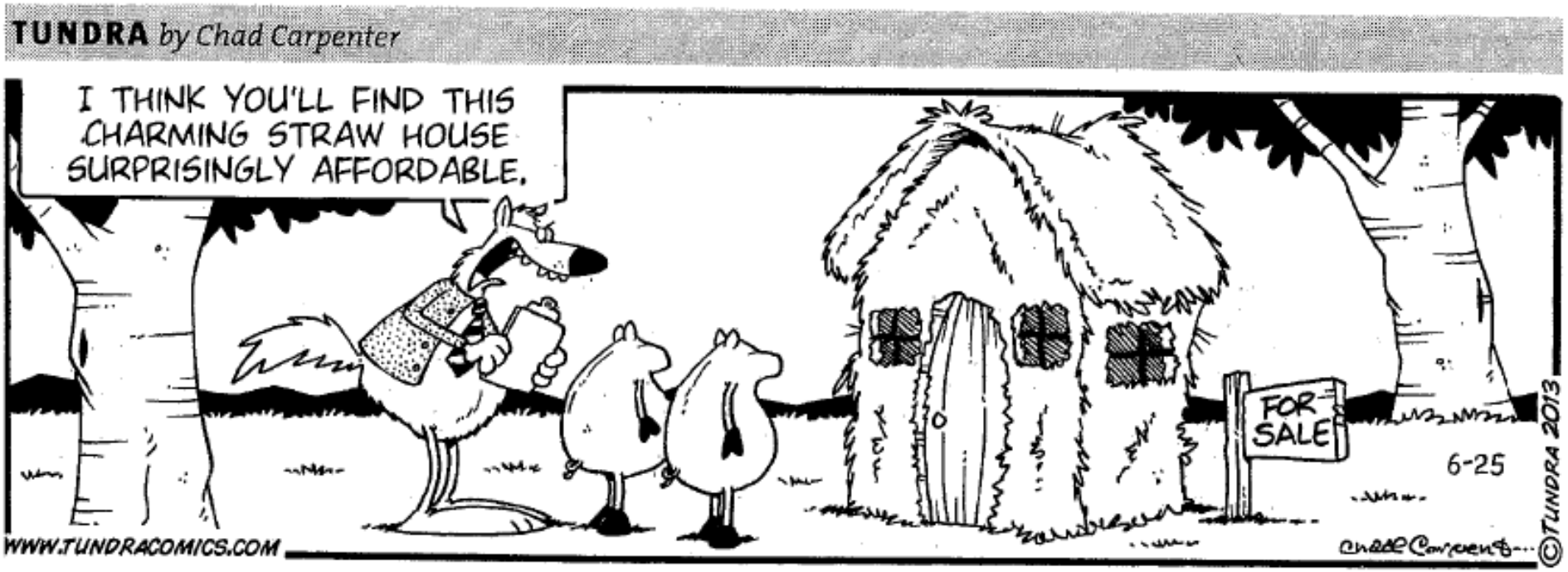
Evacuate!

From Structure

To Shelter

Out of Disaster Area

Evacuation ≠ Minimized Damage



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THANK YOU!

- Better Buildings

- Better Communities

- Better Environment

Building Stronger Communities One Building at a Time