

# Enhanced Resilience Notable Programs and Strategies

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THE WORLD'S GATHERING PLACE FOR ADVANCING CONCRETE





Source: [cambridgema.gov](http://cambridgema.gov)

# Buildings Infrastructure Communities

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# Inter-Relationship



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# Community Assessment

| Facility    | Hours |   |    |    | Days |    | Months |    |     |
|-------------|-------|---|----|----|------|----|--------|----|-----|
|             | 0     | 4 | 24 | 48 | 30   | 60 | 4      | 36 | >36 |
| Hospitals   |       |   |    |    |      |    |        | ■  |     |
| Police/Fire |       |   | ■  |    |      |    |        |    |     |
| Shelters    |       |   |    |    |      |    | ■      |    |     |
| Schools     |       |   |    |    |      |    | ■      |    |     |
| Dwellings   |       |   |    |    |      |    |        |    | ■   |
| Services    |       |   |    |    |      |    |        |    | ■   |

Based on: San Francisco Target Survey (SPUR)

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# Community Assessment

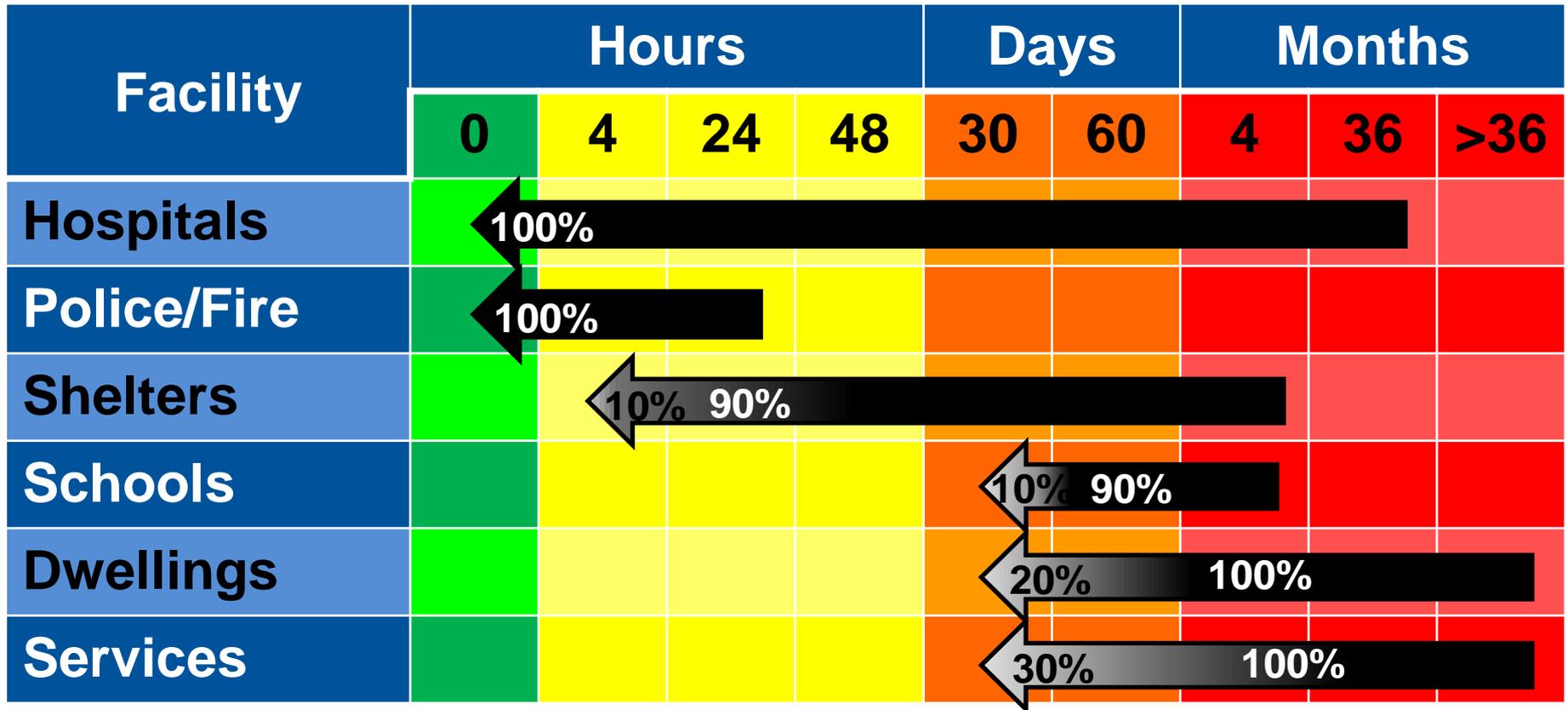
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Based on: San Francisco Target Survey (SPUR)

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# Community Assessment



Based on: San Francisco Target Survey (SPUR)

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Source: US Environmental Protection Agency



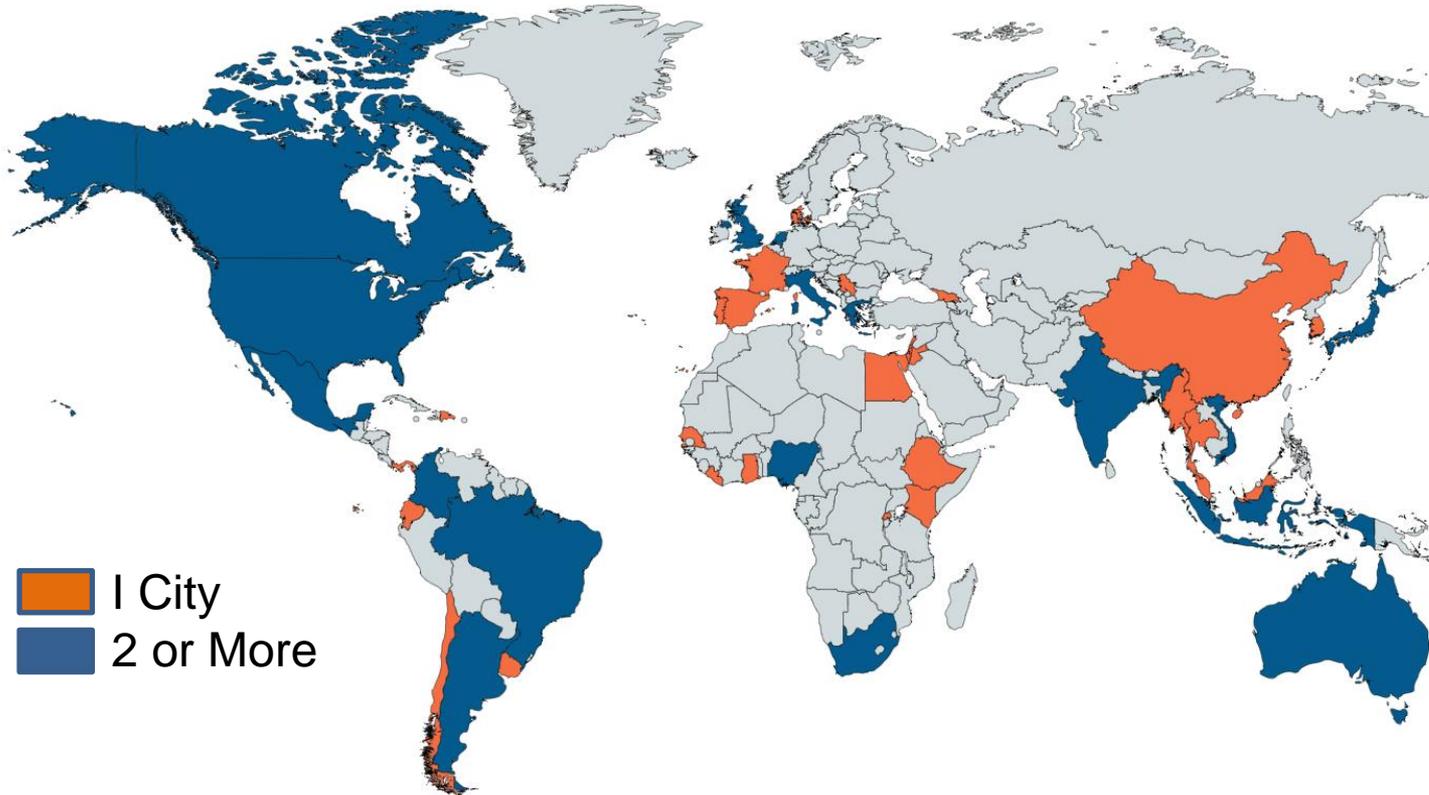
Source: National weather Service

# Impacts Can Be Far Reaching: 2005 Hurricane Katrina 2011 Tsunami in Japan

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# Rockefeller Foundation 100 Resilient Cities



1 City  
2 or More

- Argentina (2)
- Australia (2)
- Brazil (3)
- Canada (3)
- China (4)
- Columbia (2)
- Greece (2)
- India (5)
- Indonesia (2)
- Italy (2)
- Japan (2)
- Mexico (4)
- Netherlands (2)
- New Zealand (2)
- Nigeria (2)
- South Africa (2)
- United Kingdom (5)
- United States (25)
- Vietnam (2)

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# 100 Resilient Cities → Resilient Cities Catalyst rcc.city



Source: sandiego.gov

## San Francisco

climate change  
seismic events  
housing and income  
disparity

## San Diego

stormwater runoff  
urban forests  
drought conditions  
rising sea levels

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# United Nations Disaster Risk Reduction

## Sendai Framework – guide for development of public and private sector partnerships

The substantial reduction of disaster risk and losses in lives, livelihoods and health and in the economic, physical, social, cultural and environmental assets of persons, businesses, communities and countries.

# United Nations Disaster Risk Reduction

## Sendai Framework – Targets

1. Reduce disaster mortality
2. Reduce number of affected people
3. Reduce economic losses in relation to GDP
4. Reduce infrastructure damage and disruption
5. Increase number of countries with DRR strategies
6. Enhance assistance to developing countries
7. Increase use of early warning systems

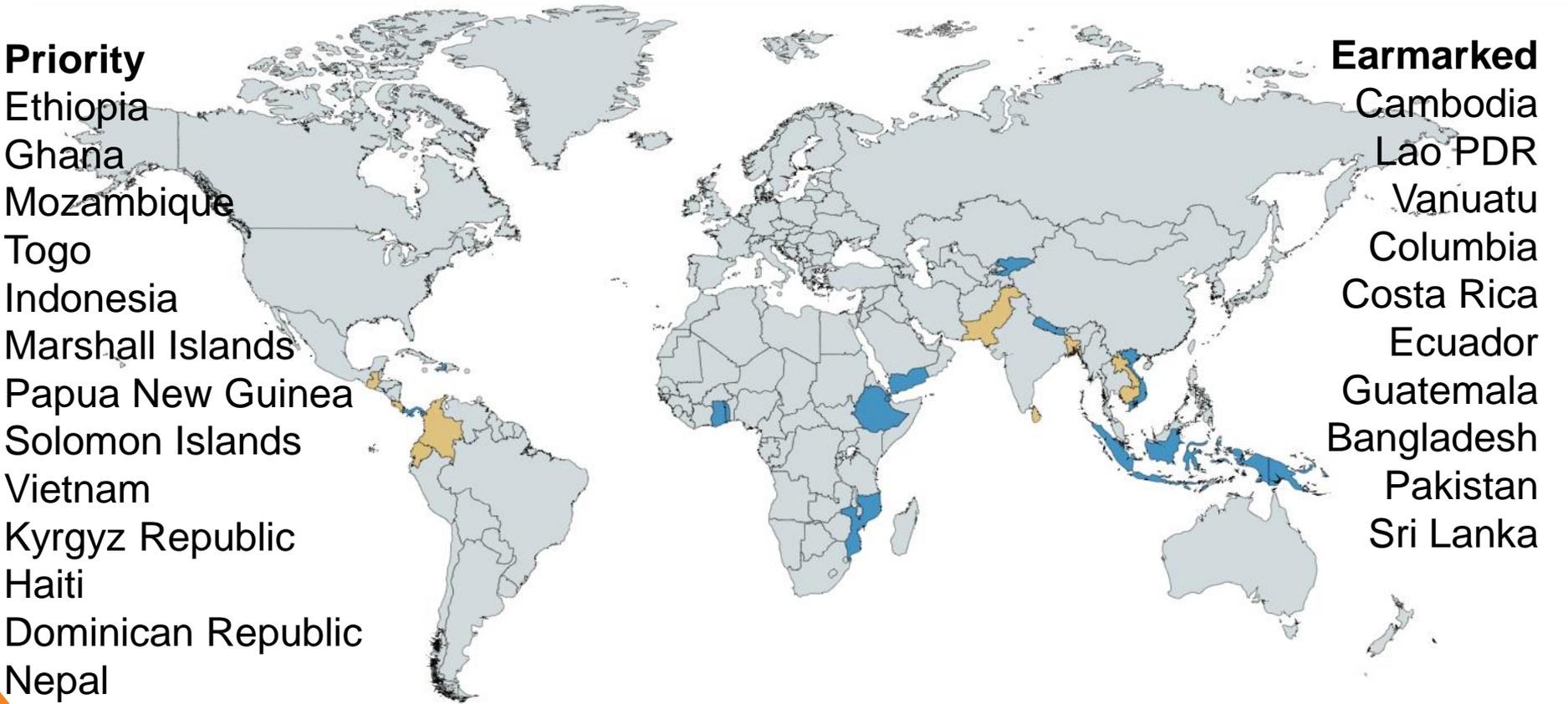
# Disaster Risk Reduction Countries

## Priority

Ethiopia  
Ghana  
Mozambique  
Togo  
Indonesia  
Marshall Islands  
Papua New Guinea  
Solomon Islands  
Vietnam  
Kyrgyz Republic  
Haiti  
Dominican Republic  
Nepal

## Earmarked

Cambodia  
Lao PDR  
Vanuatu  
Columbia  
Costa Rica  
Ecuador  
Guatemala  
Bangladesh  
Pakistan  
Sri Lanka



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# National Institute of Standards and Technology

## 1) Community resilience

Guides and analysis tools

NIST

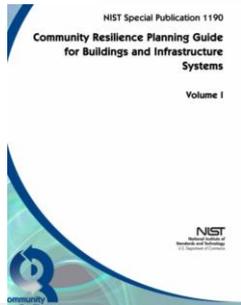
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# National Institute of Standards and Technology

## Community Resilience

*Community Planning Guide (Vol I and II)*



*Interdependent Networked Community Resilience Modeling Environment (IN-CORE)*



*Economic Decision Guide Software (Edge\$)*

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# National Institute of Standards and Technology

- 1) Community resilience
- 2) Disaster & failure studies

Investigation of structural and response failures

NIST

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# National Institute of Standards and Technology

No city would argue that building back better is undesirable...

It may be difficult to justify the huge upfront cost of such long-term investments, especially in the aftermath of a disaster when the priority is recovery.



Cedar Rapids, IA  
2008  
Flood control  
started 2016

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# National Institute of Standards and Technology

- 1) Community resilience
- 2) Disaster & failure studies
- 3) Earthquake risk reduction

Collapse assessment and Performance-Based Earthquake Engineering (PBEE)

*National Earthquake Hazard Reduction Program (NEHRP)*

# National Institute of Standards and Technology

- 1) Community resilience
- 2) Disaster & failure studies
- 3) Earthquake risk reduction
- 4) Resilient materials

Quantification of Material, Loading, and Modeling  
*Uncertainties of Reinforced Concrete Column  
Components and Frame Systems under Seismic and  
Gravity Loads for Use in PBSE*

# National Institute of Standards and Technology

## Uncertainties of Reinforced Concrete Column Components and Frame Systems

Incorporate three main sources of uncertainty to be applicable for reinforced concrete columns and frames

- a) Improve the existing component-level uncertainty
- b) Investigate the impact of loading uncertainty, and
- c) Integrate the results with work on steel beam-columns.

# National Institute of Standards and Technology

- 1) Community resilience
- 2) Disaster & failure studies
- 3) Earthquake risk reduction
- 4) Resilient materials
- 5) Windstorm impact reduction

*Calm Before the Storm: Reauthorizing the National Windstorm Impact Reduction Program*

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# National Institute of Standards and Technology

## Windstorm impact reduction

Structural Performance for Multi-hazards Program

Assessment of Available Collapse Simulation Methods  
for Use in Performance-Based Seismic Engineering  
Project

Coastal Inundation: Hazard Characterization and  
Structural Design

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# American Society of Civil Engineers

## *ASCE 7 Minimum Design Loads and Associated Criteria for Buildings and Other Structures*

Development of Tornado Load Provisions for ASCE 7-22



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# Federal Emergency Management Agency

## Federal Insurance and Mitigation Administration

### Hazard Mitigation Grant Program

Additional 5 percent Initiative for Promoting Resilience through Disaster-Resistant Building Codes

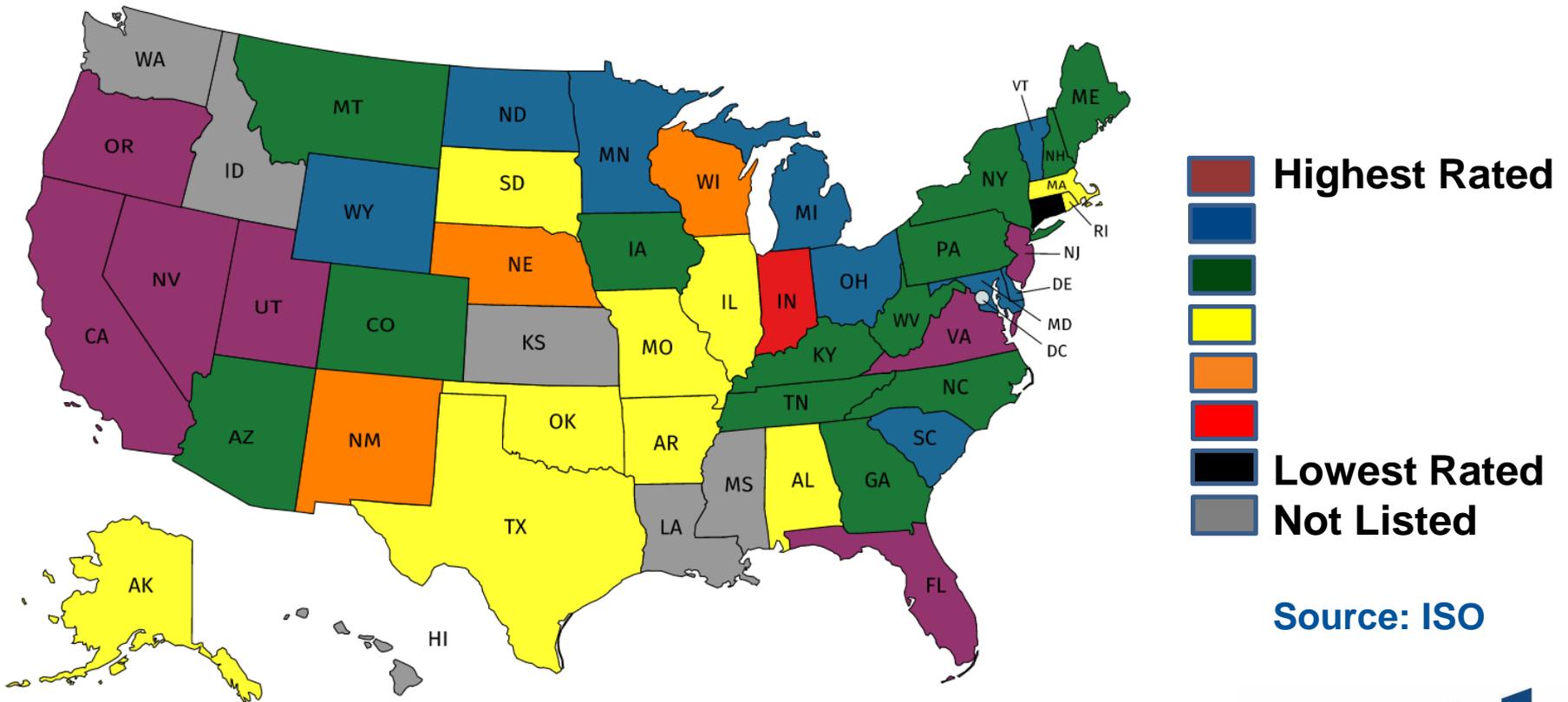
Current International Building Code® and improving a community's BCEGS score.

FEMA

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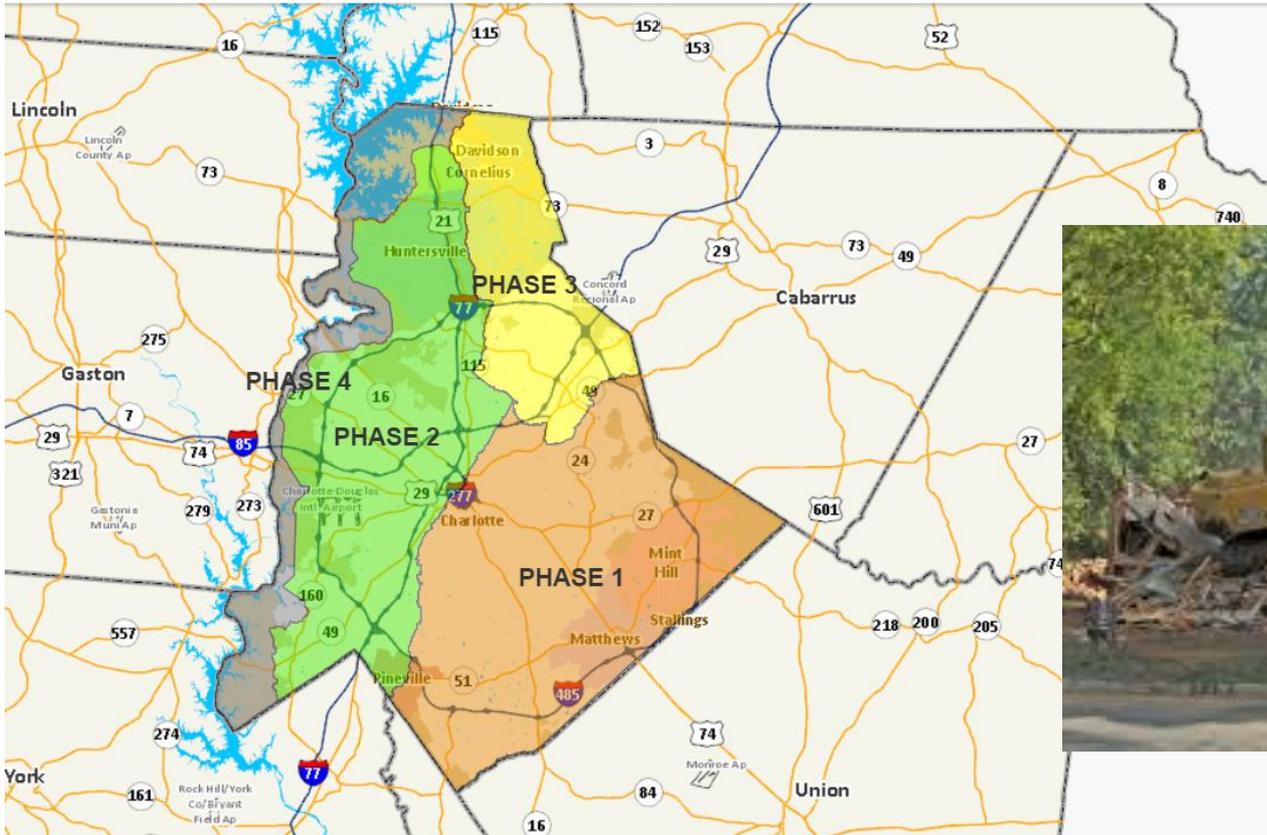
# Building Code Effectiveness Grading Schedule



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# Charlotte, NC



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# National Institute of Building Sciences

**Building Seismic Safety Council**

**Multi-Hazard Mitigation Council**

**Council on Finance Insurance and Real Estate**

**Whole Building Performance Guidelines**

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# National Institute of Building Sciences

| National Benefit-Cost Ratio (BCR) Per Peril<br><i>*BCR numbers in this study have been rounded</i>                       |              | Beyond Code Requirements | Federally Funded |
|--------------------------------------------------------------------------------------------------------------------------|--------------|--------------------------|------------------|
| <b>Overall Hazard Benefit-Cost Ratio</b>                                                                                 |              | <b>\$4:1</b>             | <b>\$6:1</b>     |
|  <b>Riverine Flood</b>                  | <b>\$5:1</b> | <b>\$7:1</b>             |                  |
|  <b>Hurricane Surge</b>                 | <b>\$7:1</b> | Too few grants           |                  |
|  <b>Wind</b>                            | <b>\$5:1</b> | <b>\$5:1</b>             |                  |
|  <b>Earthquake</b>                     | <b>\$4:1</b> | <b>\$3:1</b>             |                  |
|  <b>Wildland-Urban Interface Fire</b> | <b>\$4:1</b> | <b>\$3:1</b>             |                  |

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# FM Global

Property Loss Prevention Fact Sheets  
safeguards during construction, fire safe buildings,  
earthquakes, fire resistance, roof anchorage, exterior fire  
exposure, foreseeable loss, wind design, hail damage, flood,  
damage-limiting construction, reliability of suppression  
systems, wind turbines...

**RESILIENCE KNOWS GOOD  
ENOUGH ISN'T GOOD  
ENOUGH.**

Resilient companies base their expectations on what is achievable, not what is acceptable.

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# Anheuser-Busch – 1994 Northridge

- \$1.2 million in seismic retrofits and other upgrades
- Saved the business more than \$1.1 billion in combined property and business loss



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# International Building Code

Table 1605.5 Risk Category...

| <i>Risk Category</i> | <i>Nature of Occupancy</i>                                                      |
|----------------------|---------------------------------------------------------------------------------|
| I                    | Low hazard to human life<br>Agriculture, temporary, minor storage               |
| II                   | Building snot Category I, III, or IV                                            |
| III                  | Substantial Risk to human life<br>Large assembly, educational, institutional... |
| IV                   | Essential Facilities<br>Fire, police, shelters, hospitals...                    |



# ASCE 7

**Table 1.5-2 Importance Factors...**

| <i>Risk Category</i> | <i>Snow</i> | <i>Ice</i> | <i>Wind</i> | <i>Seismic</i> |
|----------------------|-------------|------------|-------------|----------------|
| I                    | 0.80        | 0.80       | 1.00        | 1.00           |
| II                   | 1.00        | 1.00       | 1.00        | 1.00           |
| III                  | 1.10        | 1.25       | 1.00        | 1.25           |
| IV                   | 1.20        | 1.25       | 1.00        | 1.50           |

# Risk Assessment

Large high-volume facilities - voluntary

Risk Category III and IV - mandatory

Other structures – voluntary but little opportunity for occupant influence

# Institute of Business and Home Safety

- **Wind Design** (Hurricane, High Wind and Tornado/Hail)
- **Flood Design**
- **Severe Winter Weather Design**
- **Seismic Design**
- **Wildfire Design**
- **Building Envelope and Water/Air Management**
- **Interior Fires Design**
- **Burglary Design**
- **Electrical Surge Protection**

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# Alliance for National and Community Resilience

**Develop community benchmarks for local leaders to assess and improve resilience of all community functions**

- Resilience in every segment
- Unique risk profiles
- Usable, useful and used benchmarks
- Acceptance within and outside community

# USBGC Reli 2.0

## Rating Guidelines for Resilient Design + Construction

PA: Panoramic Approach

HP: Hazard Preparedness

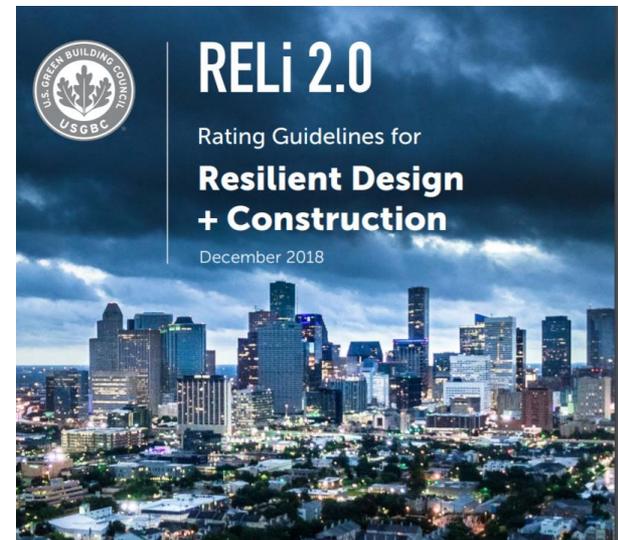
HA: Hazard Mitigation + Adaptation

CV: Community Cohesion

PH: Productivity, Health + Diversity

EW: Energy, Water, Food

MA: Materials + Artifacts



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# USBGC Reli 2.0

## **PA: Panoramic Approach (Community Level)**

Studies Analyses and Design: Short-Term Hazard, Stakeholders, Commissioning, Monitoring, Maintenance, Business and Community Continuity, Management, Regulation Conflicts, Synergies, Infrastructure Integration, Adaptability, Diversity, Redundancy, Ecology Based Perspectives

## **HP: Hazard Preparedness (Emergency Response)**

Emergency Planning, First Aid, Supplies, Water, Food, Communications, Longer Timeframes, Community Education

# USBGC Reli 2.0

## **HA: Hazard Mitigation + Adaptation Hazard Avoidance)**

Site Avoidance, Back-up Power, **Passive Survivability, Extreme Weather, Wildfire, Earthquakes,** Lighting, Critical Services, Water, **Transportation,** Environmental Protection

## **CV: Community Cohesion (Community Level)**

Quality of Life, Community Input and Connectivity, **Mixed-Use,** Social Equity, Employment, Regional Sourcing, **Sustainable Growth**

## **PH: Productivity, Health + Diversity (Human/Environmental)**

IAQ, Daylight, View, Thermal Safety: Habitat Protection, Social Equity, Interdisciplinary, Intercultural, Pesticides, Contamination, Wetlands, Biodiversity

## **EW: Energy, Water, Food (Emergency Resources)**

Water Efficiency, Landscapes, Energy Efficiency, Atmospheric, Rainwater Harvesting, Site Orientation, On-Site Renewable Energy, Edible Landscaping, Urban Agriculture, Lighting, Heat-Island, Airborne Toxins

## **MA:Materials + Artifacts**

Material Effectiveness, Life Cycle, Non-Toxic, Durability, Adaptability, Flexibility, Disassembly, Reuse, Remanufacturing, Recycling, Composting, Local Sources, Legally Logged Wood, Embodied Energy, Carbon, Water and Toxins; Landfill and Excavation Avoidance

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# ISO/TC 292 Security and resilience

## **22316 Organizational Resilience**

- resilience for any size or type of organization.

## **22301 Business Continuity Management Systems**

- prepare for, respond to and recover from disruptions

## **22320 Emergency Management**

- guidelines for incident management

## **22395 - Community Resilience**

- guidelines for supporting vulnerable persons in an emergency



# ASTM E06 Bldg. Perf. and E53 Asset Mgmt.

## **E3032 - Guide for Climate Resiliency Planning and Strategy**

- plan for extreme weather and related changes.

## **E2026 Guide for Seismic Risk Assessment of Buildings**

- assessing buildings for possible earthquake-related losses.

## **E2557 Practice for Probable Maximum Loss (PML)**

- evaluate and rate seismic risk for buildings

## **E3075 Test Method for Water Immersion and Drying**

- evaluation of flood damage resistance

## **E3210 Practice for Infrastructure Management**

- asset management

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# American Concrete Institute

**562:** Code Reqts. Assessment, Repair, and Rehabilitation

**364.1R:** Guide on Assessment Before Rehabilitation

**369.1:** Standard for Seismic Evaluation and Retrofit

**365.1R:** Report on Service Life Prediction

**437R:** Strength Evaluation of Existing Concrete Buildings

**437.2:** Code Reqts for Load Testing

**130R:** Report on Materials in Sustainable Concrete

**370R:** Report for the Design for Blast Effects

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# U.S. Resiliency Council

| Rating | Safety         | Damage | Recovery           |
|--------|----------------|--------|--------------------|
| ★★★★★  | Exit Paths     | <5%    | Immediate/<br>Days |
| ★★★★   | Injuries       | <10%   | Days/<br>Weeks     |
| ★★★    | No Live        | <20%   | Weeks/<br>Months   |
| ★★     | Isolated Lives | <40%   | Months/<br>Year    |
| ★      | Lives Likely   | >40%   | >Year              |

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# Resilience

The capacity of individuals, communities, institutions, businesses, and systems to survive, adapt, and grow no matter of:

| Chronic Stresses       |              | Acute Shocks            |              |
|------------------------|--------------|-------------------------|--------------|
| Earthquake             | Terrorism    | Water Scarcity          | Poverty      |
| Wildfires              | Disease      | Poor Housing            | Crime        |
| Sandstorms             | Riots        | Poor Air Quality        | Unemployment |
| Extreme Cold           | Storms       | Macroeconomics          | Homelessness |
| HAZMAT                 | Extreme Heat | Changing Demographics   |              |
| Infrastructure Failure |              | Aging Infrastructure    |              |
|                        |              | Lack of Social Cohesion |              |

*Thank You!*

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