National Institute of BUILDING SCIENCES™
Innovative Solutions for the Built Environment

Mitigation Saves:
Mitigation Saves up to $13 per $1 Invested

EVERY AMERICAN FACES NATURAL HAZARDS, AND THE RISK IS GROWING

U.S. disaster losses from wind, floods, earthquakes, and fires now average $100 billion per year, and in 2017 exceeded $300 billion—25% of the $1.3 trillion building value put in place that year. Fortunately, there are affordable and highly cost-effective strategies that policymakers, building owners, and the building industry can deploy to reduce these impacts. These strategies include adopting and strengthening building codes, upgrading existing buildings, and improving utilities and transportation systems. The benefits and costs associated with these mitigation measures have been identified through the most exhaustive benefit-cost analysis of natural hazard mitigation to date and documented in Natural Hazard Mitigation Saves. The study was funded by three federal agencies and four private-sector sponsors and produced by the National Institute of Building Sciences – the nation's Congressionally chartered convener of experts from the building professions, industry, labor, consumer interests, and government. For the report and accompanying fact sheets, see www.nibs.org/mitigationsaves. This fact sheet summarizes the study findings and significant savings associated with various mitigation measures.

- **Adopting the latest building code requirements is affordable and saves $11 per $1 invested.** Building codes have greatly improved society's disaster resilience, while adding only about 1% to construction costs relative to 1990 standards. The greatest benefits accrue to communities using the most recent code editions.
- **Above-code design could save $4 per $1 cost.** Building codes set minimum requirements to protect life safety. Stricter requirements can cost-effectively boost life safety and speed functional recovery.
- **Private-sector building retrofits could save $4 per $1 cost.** The country could efficiently invest over $500 billion to upgrade residences with 15 measures considered here, saving more than $2 trillion.
- **Lifeline retrofit saves $4 per $1 cost.** Society relies on telecommunications, roads, power, water, and other lifelines. Case studies show that upgrading lifelines to better resist disasters helps our economy and society.
- **Federal grants save $6 per $1 cost.** Public-sector investment in mitigation since 1995 by FEMA, EDA, and HUD cost the country $27 billion but will ultimately save $160 billion, meaning $6 saved per $1 invested.

National Institute of BUILDING SCIENCES™	ADOPT CODE	ABOVE CODE	BUILDING RETROFIT	LIFELINE RETROFIT	FEDERAL GRANTS
Overall Benefit-Cost Ratio	11:1	4:1	4:1	4:1	6:1
Cost ($ billion)	$1/year	$4/year	$520	$0.6	$27
Benefit ($ billion)	$13/year	$16/year	$2200	$2.5	$160
Riverine Flood	6:1	5:1	6:1	8:1	7:1
Hurricane Surge	not applicable	7:1	not applicable	not applicable	not applicable
Wind	10:1	5:1	6:1	7:1	5:1
Earthquake	12:1	4:1	13:1	3:1	3:1
Wildland-Urban Interface Fire	not applicable	4:1	2:1	not applicable	3:1

TABLE 1. Nationwide average benefit-cost ratio by hazard and mitigation measure. BCRs can vary geographically and can be much higher in some places. Find more details in the report.

THERE ARE MANY WAYS TO BETTER PROTECT SOCIETY FROM NATURAL DISASTERS

NIBS has updated and expanded its groundbreaking 2005 study for the U.S. Congress on the cost-effectiveness of natural-hazard mitigation. The new study examines more approaches to mitigation, beyond the federally funded retrofit measures considered in the first study. Other fact sheets summarize these big takeaways:

Adopting and enforcing current building codes is among the most efficient ways to build a resilient society.

- The home of Pamela and Warren Adams in Gilchrist, Texas, survived Hurricane Ike in 2008 because it complied with code requirements for elevation. Neighbors with noncompliant homes lost everything.
- Building 1 foot above the 100-year flood elevation is cost effective, adding only $90 million of construction cost per year for new construction, while saving $550 million, a 6-to-1 benefit-cost ratio.
- Building-code hurricane requirements save an average of $10 per $1 of added cost ($5.6 billion saved for an annual investment of $540 million), with benefit-cost ratios that reach as high as 30 to 1.
- Enhanced earthquake design requirement over the last 30 years save $7 billion per year of new construction while only adding $600 million per year in construction cost, with benefit-cost ratios that in some places reach as high as 32 to 1.

Model codes make buildings safe, but above-code design can reduce both damage and long-term costs.

- Paul Jackson of Mexico Beach, Florida, built his home to comply with the higher requirements of IBHS FORTIFIED Home. His home survived Hurricane Michael. Those of his neighbors didn't.
- Buildings in riverine floodplains could cost-effectively be built with up to 5 feet of freeboard rather than 1 foot, saving $4.2 billion in avoided future losses at a cost of $900 million, a savings of 5 to 1.
- In most coastal locations subject to hurricane surge, it can be cost effective to build the first floor up to 10 feet above base flood elevation, in some places saving more than $12 per $1 of added cost.
- Building along the Gulf and Atlantic coasts to comply with IBHS FORTIFIED Home requirements would cost $720 million, but save $3.8 billion per year, with some benefit-cost ratios over 16:1.
- New buildings in earthquake country could be made 3 times stronger and stiffer than code and cost less in the long run: $4.3 billion saved for $1.2 billion cost. Some places save more than $8 per $1 invested.
- In 10,000 census blocks across the country, adopting the International Wildland-Urban Interface Code would cost $800 million per year and save $3 billion, with some places saving over $6 per $1 invested.

The nation could invest over $500 billion to retrofit existing buildings but save over $2.2 trillion.

- Anheuser-Busch spent $11 million to retrofit its Van Nuys, California brewery just before the 1994 Northridge earthquake and saved $2 billion, while protecting its market share and employees.
- More than 1 million older houses stand in the 100-year floodplain. Buyouts, elevation projects, and other retrofits could save society $1.3 trillion at a cost of $230 billion—$6 saved per $1 invested.
- Private-sector retrofits for hurricane could save society $140 billion at a cost of $24 billion—a 6:1 benefit-cost ratio from retrofitting 3 million single-family dwellings and 130,000 manufactured homes.
- Seismic retrofits could save $330 billion at a cost of $25 billion by fixing soft-story dwellings, adding engineered tie-down systems to manufactured homes, and several low-cost nonstructural measures.
- It would save $430 billion to make 2.5 million homes in the wildland-urban interface comply with the 2018 International Wildland-Urban Interface Code. It would cost between $53 billion and $240 billion to do so, so the nationwide benefit-cost ratio could be as high as 8:1 or conservatively 2:1

Retrofitting lifelines protects the whole economy, saving up to $31 per $1 invested.

- A grant to Greenville Utilities of North Carolina was used to raise a berm and floodwall around its water treatment plant, protecting it from more than 3 feet of flooding during Hurricane Matthew in 2016.
- Activities that enhance resilience of water and wastewater facilities, electric utility substations, roads and railways, and communications equipment yielded benefit-cost ratios as high as 31 to 1.

Federal grants saved $160 billion and cost $27 billion, a 6:1 ratio, with savings in each state.

- Buyouts after the 1993 Midwest floods brought people peace of mind and protection.
- A variety of federal mitigation grants to make public buildings better resist floods, earthquakes, and hurricanes save the federal treasury almost $1 billion annually.

MUCH REMAINS UNKNOWN ABOUT POTENTIALLY VALUABLE MITIGATION MEASURES

No study provides all the answers. Figures 1-5 illustrate open questions about high-risk commercial buildings, business continuity plans, stricter lifeline design, warning systems, and protecting vulnerable populations.

Many more questions beg for answers that could save the nation billions of dollars and thousands of lives:

- What shall we do about tens of thousands of elevators that lack emergency power, and could trap occupants for days after a big earthquake?

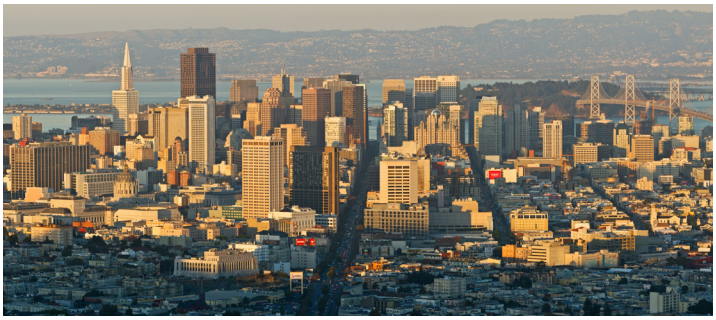

FIGURE 2. Should we ignore, fix, or demolish thousands of vulnerable concrete and steel-frame buildings in earthquake country?

FIGURE 3. Should utilities and transportation infrastructure be designed to remain functional rather than merely not kill people?

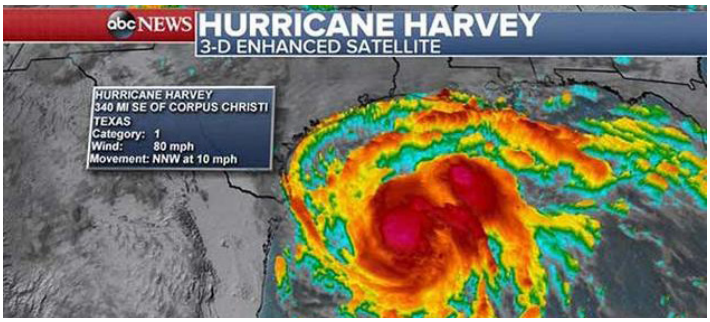

FIGURE 4. Government warning systems can provide hours or days of advanced warning. Does it make sense to cut their budget?

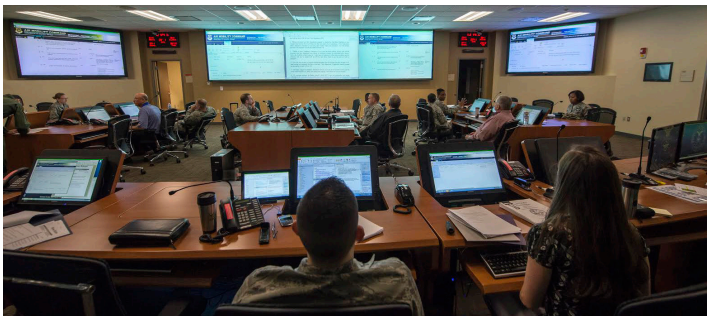

FIGURE 1. Continuity plans can make the difference between business survival and bankruptcy. What is their benefit-cost ratio?

FIGURE 5. Disasters hit disadvantaged populations harder. How can benefit-cost analyses better account for that?

- Would it make sense to repair damaged buildings and infrastructure to current or above-code levels?
- How broadly does design or upgrade to meet or exceed code levels improve resale value?
- What are the most affordable, cost-effective measures for improving schools and other critical facilities?
- Does the Federal Office of Management and Budget (OMB) statutory discount rate of 7% make economic and ethical sense?
- Does OMB's valuation of mitigation measures accurately capture their benefit to the U.S. government?
- How can the economic analysis tools used by the Congressional Budget Office (CBO) Joint Committee on Taxation (JCT) be improved to adequately estimate future benefits of mitigation?
- How cost effective is incremental rehabilitation: strengthening buildings during normal maintenance?
- How can code developers estimate the benefits of new requirements when they consider adopting them?
- How can the people who benefit from mitigation without paying for it fairly incentivize owners to improve new and existing buildings?
- How can we best teach ordinary people about mitigation and resilience?

NIBS hopes to answer these questions and more, in furtherance of its mission to resolve present and future problems and to promote the construction of safe, affordable structures for housing, commerce, and industry throughout the United States. To help NIBS do that, please contact Jiqiu (JQ) Yuan, **jyuan@nibs.org**, Executive Director of the Multihazard Mitigation Council and Building Seismic Safety Council, National Institute of Building Sciences. Visit **nibs.org** to learn more about how NIBS helps to advance building sciences and technology for the benefit of the nation.