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

Mitigation Saves: For Hurricane Surge, Designing to Exceed 2015 Codes Provides $7 Benefit for Each $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.

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RESULTS OF EXCEEDING CODE

Building new single-family dwellings higher above the base flood elevation (BFE) than the 1-foot required by the 2015 IRC appears to be cost-effective in coastal surge areas identified as V or VE by FEMA in all states. Surge in coastal V-zones is different from riverine flooding, and so its costs and benefits are different.

When the incrementally efficient maximum (IEMax) increase in building height is assessed on a state level, the aggregate BCR (summing benefits and costs over all states) is approximately 7:1, e.g., $7 saved for every $1 spent to build new coastal buildings in V- and VE-zones higher above the shoreline. It would cost approximately $7 million extra to build all new buildings to the IEMax elevation above BFE for one year, and would produce approximately $51 million in benefits.

Table 1 provides BCRs for each natural hazard the project team examined. Figure 1 shows the overall ratio of costs to benefits for the design of new buildings to exceed hurricane related coastal flooding requirements of the 2015 IRC. The IEMax additional height varies by state, as illustrated in Table 2. The results strongly suggest that greater elevation of new coastal single-family dwellings in V-zones is widely cost-effective. All states have an IEMax building height above code of at least 5 feet. These costs and benefits refer to building new coastal single-family dwellings higher above BFE, not of elevating existing houses. The project team aggregated state and local BCRs to determine the national-level BCR. The costs reflect only the added cost relative to the 2015 IRC.

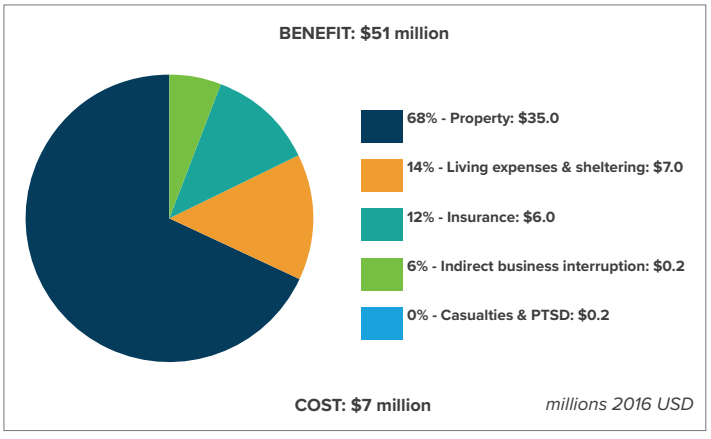

FIGURE 1. Nationwide benefits by category for designing to exceed 2015 I-Code requirements for flood.

The stringency of codes adopted at the state and local level varies widely. The project team used the unamended 2015 IBC and IRC as the baseline minimum codes for this study. While minimum codes provide a significant level of safety, society can save more by designing some new buildings to exceed minimum requirements of the 2015 Codes. Where communities have an older code or no code in place, additional costs and benefits will accrue. If all new buildings built the year after were also designed to exceed select I-Code requirements, the benefits would be that much greater, in proportion to the quantity of new buildings.

STATE	FIRST FLOOR HEIGHT ABOVE BFE UP TO IEMAX	BCR
Texas	+2 to 8	20.2 to 9.1
Louisiana	+2 to 10	11.3 to 4.8
Mississippi	+2 to 10	27.6 to 10.1
Alabama	+2 to 10	31.1 to 11.7
Florida	+2 to 10	21.1 to 8.4
Georgia	+2 to 6	6.7 to 3.8
South Carolina	+2 to 10	11.8 to 5.0
North Carolina	+2 to 10	12.6 to 5.2
Virginia	+2 to 6	6.7 to 3.8
Delaware	+2 to 6	6.7 to 3.8
Maryland	+2 to 6	6.7 to 3.8
New York	+2 to 6	6.7 to 3.8
New Jersey	+2 to 6	6.7 to 3.8
Connecticut	+2 to 6	6.7 to 3.8
Rhode Island	+2 to 6	6.7 to 3.8
Massachusetts	+2 to 6	6.9 to 3.9
TOTAL		**16.9 to 7**

TABLE 2. BCRs for various heights above BFE for new coastal V-zone buildings up to the point where the incremental benefitremains cost-effective.benefitremains cost-effective.

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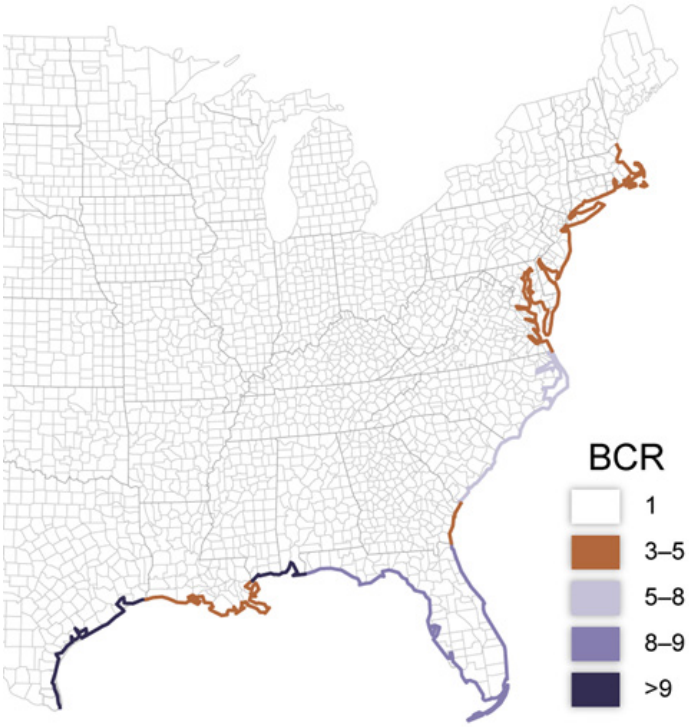

FIGURE 2. BCR of coastal flooding mitigation by elevating homes above 2015 IRC requirements (by state).