Building Codes Save: A Nationwide Study of Loss Prevention

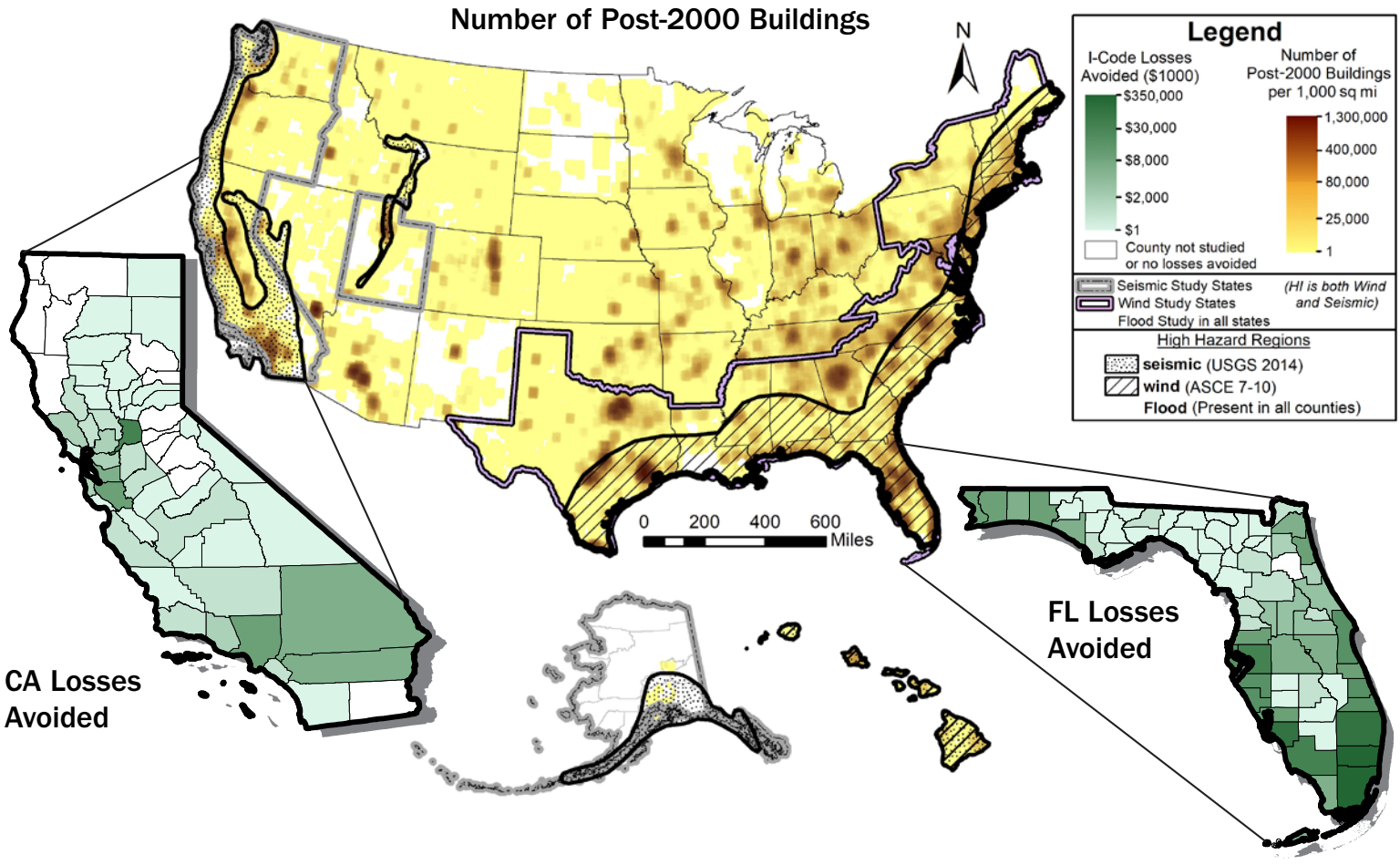
FACT SHEET April 2020

How much money will modern building codes save your community?

Interim findings for **California** and **Florida** adopting and enforcing modern hazard-resistant building codes **over the past 20 years** indicate a long-term average **future savings of $1 billion per year** for those two states combined. These findings are from the Federal Emergency Management Agency's (FEMA) ongoing Building Codes Save (BCS) initiative, a first-of-its-kind, engineering-based study whose results will include nationwide parcel-level modeling of **savings for 17 million buildings** constructed in the U.S. after the launch of the year 2000 International Building Code (IBC®) and the other International Codes (I-Codes®). This 20-year accumulation is estimated to be about 15% of the total inventory of buildings nationwide.

The BCS modeling uses FEMA's Hazus software to analyze modern buildings constructed in hazard-prone areas. This study aims to quantify the anticipated modeling results are that additional billions of dollars in future losses will be avoided nationwide by adopting the hazard-resistant IBC 2000 provisions, and later editions. The savings reported are reduced average annualized losses derived by comparing the anticipated losses had these buildings had been designed to earlier 1990s-era building codes. The losses avoided include reduced or avoided damage to buildings and contents from three types of natural hazard events: flooding, hurricane wind, and earthquakes.

The figure below shows nationwide distribution of buildings built to the I-Code and the interim results for California and Florida, which are the two dominant hazard-prone, high growth states that led the development of hazard-resistant building codes before 2000. Many of their code provisions were adopted into the 2000 I-Codes. By quantifying the avoided damage to buildings from flooding, hurricane wind, and earthquakes, the combined savings from these two states demonstrate the high value of adopting I-Codes for hazard mitigation as a return on investment.



Interim Findings of Modeled I-Code Savings

Flood

Model considers freeboard and requires buildings to have a design flood elevation higher than the minimum elevation standard.

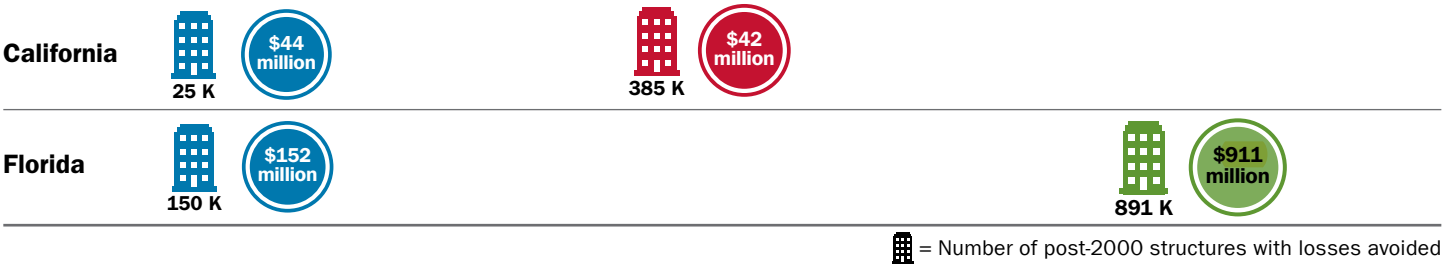
Seismic

Model considers results of buildings designed to withstand greater levels of shaking from mapped increased seismic hazard.

Hurricane Winds

Model considers required exposure design in Florida High Velocity Hurricane Zone and missle-impact resistance in the Windborne Debris Region, and other code improvements.

Total annual average losses avoided based on building and content damages



In addition, there are other realized benefits related to reducing physical damage, including: **reduced economic impacts** (such as lost rent and relocation costs) and **reduced indirect disaster costs** (lost productivity; impacts on health, education, the environment, social well-being, and financial health of the community). While the BCS study does not model these economic impacts or indirect cost savings, they compound the savings and may be further researched via the *Mitigation Saves* study link at the end of this Fact Sheet.

How was the data processed and modeled?

Data Inputs

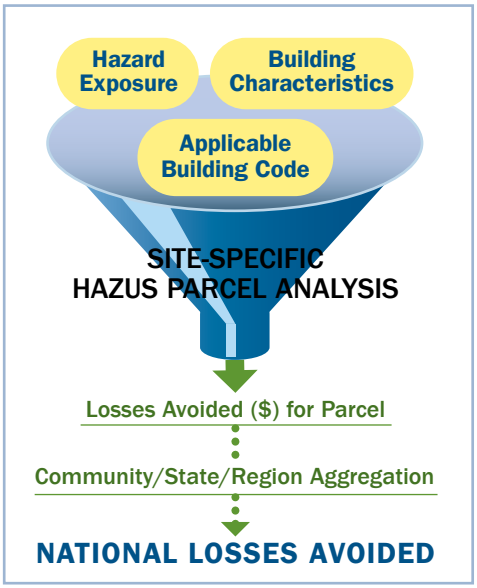
- Primary building parcel data (CoreLogic)
- Hazard maps and code design provisions (I-Codes, ASCE 7, U.S. Geological Survey, Florida Building Code)
- Damage functions (Hazus, U.S. Army Corps of Engineers)
- Secondary building parcel data footprints (Microsoft Bing)
- Pre-2000 code provisions (Uniform Building Code 1997 – CA; SBC – FL)
- Freeboard and code history (Community Rating System and ISO Building Code Effectiveness Grading Schedule)

Data Processing

- ArcGIS and AWS PySpark data platforms for processing of 147M total building records screened to 17M post-2000 parcels, using dozens of attributes per parcel
- Key modeling attributes: building location, year built, building code version used, size, construction type/features, occupancy/use, and replacement value
- Filter and rectify errata, pre-2000 parcels, blanks, <500 square feet, and coordinates
- Join stacked apartment parcels/large buildings spanning multiple parcels (mixed use)
- Assign parcel census block/tract, mapped hazard exposure (wind speed, flood elevation, and seismic shaking), and building replacement value (building and contents)

Modeling Procedure

- Assign Hazus model building type, design level, and construction type
- Map Hazus damage functions to parcels to simulate I-Code improvement
- Run Hazus with and without I-Code improvements, customizing by hazard



Hazards Methods

Flood

- Replicate Hazus individual structure flood damage modeling in a cloud-based database environment
- Create national freeboard database for every NFIP-participating community from 2000-2018
- Develop expanded flood depth-damage functions for riverine and coastal flood hazards, including wave conditions
- Model all 50 states and the District of Columbia

Seismic

- Assign Hazus Design Levels (lateral strength of each building)
- Assign Hazus Model Building Type (structural system for each building)
- Customize damage functions
- Automate Hazus runs for eight return periods to develop average annual losses avoided
- Model the six western seismic states

Hurricane Winds

- Build a new Hazus computational "engine" that is adding key code-mandating loss drivers:
  - Roof deck attachment
  - Roof-to-wall connections
  - Full load path design
  - Window design pressure
- Model 21 Hazus hurricane states plus the District of Columbia

Have all states and territories adopted minimum statewide building codes?

The BCS study evaluated building code adoption throughout the country. While many states have adopted the modern I-Codes statewide, significant gaps remain.

- **Flood:** Eighteen states have not adopted statewide minimum freeboard requirements.
- **Wind:** Eight states have weakened some minimum wind provisions or made them optional.
- **Seismic:** Ten states have not mandated statewide adoption and may have counties with limited seismic provisions.

What are the most important findings at this stage of the study?

Billions are Saved from Direct Losses
Adoption of post 2000 I-Codes over the past 20 years will save billions of dollars in future avoided losses related to direct building and content damages.

Increased Savings for Indirect Losses *(See 2018 Mitigation Saves study)*
Significant additional code-driven community savings will be realized when considering reduction or avoidance of:

- Lost productivity
- Repetitive Loss
- Community costs of recovery
- Environmental damage
- Weakened financial standing and ratings

How Do I Learn More?

Contact: The Building Science Helpline at 866-927-2104 or FEMA-BuildingScienceHelp@fema.dhs.gov

Subscribe: To FEMA Building Science updates at http://bit.ly/BSB_GovDelivery

Visit: The Building Codes Saves site for updates on the nationwide published study to be released later in 2020: https://www.fema.gov/building-codes-save-nationwide-study-loss-prevention