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# How Much Less Damage Would a Severe Hurricane Do If Houses in Its Path Were Built to Up-to-Date Building Codes? An Illustration

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# I. Introduction

Hurricane-induced wind damage remains a primary driver of property losses in U.S. coastal regions. Extensive research in wind engineering and building science has demonstrated that stronger construction standards and effective building codes can substantially reduce structural and nonstructural damage during extreme wind events. However, building code adoption, enforcement, and evolution vary widely across states and local jurisdictions, resulting in significant differences in wind vulnerability across regions exposed to similar hurricane hazards.

These differences in wind vulnerability are closely linked to how residential building codes have evolved over time. National model codes governing residential construction have changed substantially over the past several decades, particularly in response to lessons learned from major hurricanes. The transition from regional codes such as the Standard Building Code (SBC) to the International Residential Code (IRC) reflects a shift from a primary focus on structural wind loads toward a more integrated treatment of building envelope performance, component-level resistance, and wind-borne debris protection. Because residential building stocks evolve slowly, the residential code in effect at the time of construction plays a central role in shaping long-term wind vulnerability and hurricane loss outcomes.

This study is conducted in two parts. Part 1 leverages the Karen Clark & Company (KCC) Hurricane Model to quantify the sensitivity of hurricane loss outcomes to differences in building codes and construction practices. Through a controlled modeling experiment centered on the 1900 Galveston Hurricane, the analysis evaluates the reduction in property losses from hypothetical scenarios in which portions of the coastal Texas single-family residential building inventory are assumed to meet the IRC standards appropriate for the wind hazard regime.

KCC engineers selected Texas as the focus of the study because, despite its substantial hurricane exposure, the state lacks a uniformly enforced statewide residential building code. This results in significant variability in code adoption and enforcement across local jurisdictions, as well as slower adoption of wind-related building code standards, leaving portions of the residential building inventory vulnerable to hurricane damage.

Part 2 presents a classic benefit-cost analysis, comparing the costs of stronger building codes to the benefits in terms of property loss reduction. Together, the two analyses provide insight into both the risk reduction and economic value associated with stronger residential building standards.

While the study focuses on Texas, the methodology can be applied to other states and regions.

# II. Overview of the KCC Hurricane Model

Catastrophe modeling technology is the standard methodology used by the global (re)insurance industry to assess and manage extreme event risk. Risk metrics derived from the catastrophe models, such as Probable Maximum Loss (PML) and Average Annual Loss (AAL), are mandatory reporting metrics for internal and external stakeholders, such as boards, regulators, and rating agencies.

Catastrophe models project future events, particularly the financial consequences of those events. Specifically, catastrophe models project the impacts that extreme events—such as hurricanes, severe convective storms (SCS), and wildfires—will have on individual properties and portfolios.

As opposed to deterministic projections, catastrophe models provide probabilistic output on the likelihood of losses of different sizes.

By prioritizing scientific, data-driven analyses, catastrophe models enable more accurate risk pricing and sound portfolio management decisions for all locations, including areas that have not experienced a major event in recent history.

The structure of the KCC Hurricane Model aligns with the structure of catastrophe models in general. The model has four primary modules, and the primary output is the Exceedance Probability (EP) curve illustrating the probability of losses of different magnitudes.

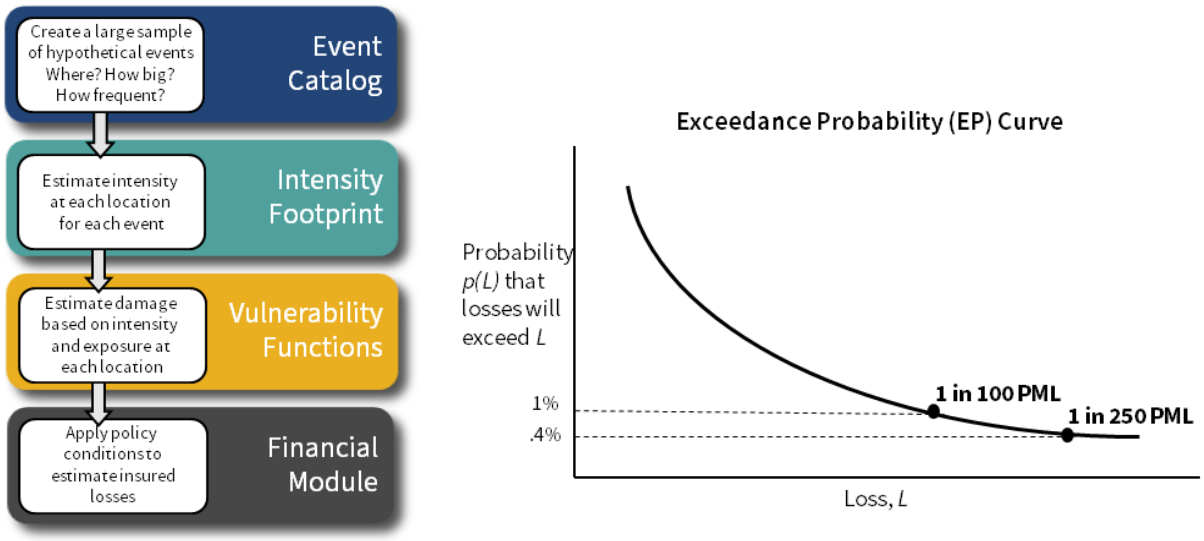



**Figure 1 - Components of a catastrophe model (left) and illustrative example of an EP curve (right)**

## II.A. Event Catalog Module

The Event Catalog includes tens of thousands of potential future hurricanes that capture the expected frequency, distribution of intensities, and other hurricane characteristics by location. Catastrophe models rely on large catalogs of simulated events because the historical record is too limited to fully capture the range of storms that could impact a location. Although historical observations provide essential insight into hurricane behavior, they represent only a small subset of the possible combinations of storm intensity, size, motion, and track that are consistent with long-term climatology. The Event Catalog contains enough potential hurricanes to fill in the gaps inherent in the historical dataset. The model can also simulate individual events—both historical and hypothetical.

To generate an accurate representation of hurricane risk, the event frequencies and other hurricane characteristics in the Event Catalog are determined through analyses of historical data along with meteorological expertise.

The parameters in the Event Catalog include:

- **Peak wind speed at landfall** ($V_{max}$), which is the primary determinant of storm intensity. $V_{max}$ is defined by the one-minute sustained wind speed at 10-m height. KCC scientists leverage historical data, statistical techniques, and meteorological expertise to develop the distribution of $V_{max}$ for each landfall point.

- **Radius of maximum winds** ($R_{max}$), which influences the geographical extent of the wind footprint for each event. Stronger storms typically have a smaller $R_{max}$ and weaker storms have a larger $R_{max}$ because of the dynamics of the inner circulation of strong low-pressure systems like hurricanes. For each event, the $R_{max}$ changes as the storm propagates and the wind speeds evolve. These changes in the size of the windfield are consistent with observed hurricanes and the scientific literature.

- **Forward speed,** which affects the asymmetry of the windfield and how far inland high winds will penetrate. In general, a storm with a faster forward speed will have greater asymmetry and be able to cross further inland before winds decay significantly.

- **Storm track,** which determines the geographical distribution of wind speeds over land. Rather than generating random track directions based on the limited historical dataset, KCC scientists determine the range of most likely storm tracks at each landfall point through analyses of hurricane climatology. This ensures that there is a smooth transition in track angle and consistent spacing between landfall points while maintaining the climatology of storm movement after landfall.

- **Central pressure,** which is necessary to calculate the peak storm surge. Hurricane winds are proportional to the gradient of air pressure from the storm periphery to the storm center. Central pressure can therefore be derived from $V_{max}$. Central pressure at each time step is calculated as a function of $V_{max}$, latitude, and storm size at each time step. Hurricanes with lower central pressure generally result in higher storm surge.

KCC scientists incorporate climate change into the KCC Hurricane Model by climate conditioning the historical data to reflect the maximum wind speed that past hurricanes would have if they occurred in the current climate. The amount of climate change trending applied to the historical intensity data depends on the landfall wind speed and on the amount of climate change since the landfall year, with sea surface temperature trends leveraged as a proxy for climate change.

The impact on individual historical events is greatest for the oldest events, which occurred in the relatively coolest climate, and it decreases toward zero as the year of occurrence approaches the present day. The 1900 Galveston Hurricane made landfall with maximum sustained winds of 138 mph—a Category 4 hurricane. However, if it were to occur under today's climate, the landfall wind speed would likely reach 145 mph.

## II.B. Intensity Footprint Module

KCC scientists utilize the most current data, research, and technical literature to calculate wind and storm surge intensities at the location level. The loss analysis in this study focuses on wind-driven damage to isolate the effects of wind-related building codes. Storm surge footprints are presented for contextual completeness, given their historical importance for the 1900 Galveston Hurricane.

The wind intensity footprints are calculated with radial wind speed profile formulas combined with asymmetry, overland decay, and surface friction components.

Track data inputs representing the hurricane center location, intensity, and wind field size are calculated for every five-minute time step to drive the **radial wind speed profile**. Winds inside the eyewall are estimated as a non-linear function of distance from the eye, and winds outside the eyewall follow an exponential decay function that depends on $V_{max}$ and $R_{max}$. More intense hurricanes tend to have smaller windfields and therefore a smaller $R_{max}$, with the strongest winds often extending only a short distance from the center.

The forward motion of a storm produces an asymmetric wind field. In the Northern Hemisphere, this results in higher winds on the right side of the track and lower wind speeds on the left. This effect is represented by an **asymmetry** parameter that accounts for the forward speed of the hurricane and the angle between the track direction and the local wind direction.

Hurricanes derive their energy from the ocean and weaken after landfall as that energy source is removed. This **overland decay** is accounted for by an exponential function that captures the observed differences in decay rates for different intensities and regions.

Surface characteristics further influence wind speeds as storms move over land. Rough land cover, like developed urban areas or dense forests, slows the winds through **surface friction** effects. These impacts depend on upwind surface conditions over a distance known as the fetch. Directional surface-roughness effects are incorporated to ensure location-level wind speeds reflect upwind terrain characteristics.

All calculations for the radial wind speed, asymmetry, overland decay, and surface friction are performed for every five-minute timestep along the hurricane track. The maximum wind speed for each location on a one-kilometer grid defines the wind intensity footprint for the event.

The storm surge intensity footprints are developed to characterize flooding associated with hurricane landfall. Peak surge is driven primarily by the interaction of high winds with the ocean's surface, with an additional contribution from the reduced atmospheric pressure in the storm center. Storm size, track direction, and coastal geometry influence the spatial extent of surge along the coastline.

Inundation depths depend on land cover, ground elevation, and the speed of the storm. Where present, mitigation devices such as levees and sea walls are also incorporated into the model. The maximum depth at a 30-m resolution for every five-minute timestep comprises the final storm surge intensity footprint.

### II.B.1. Intensity Footprints for 1900 Galveston Hurricane

The 1900 Galveston Hurricane made landfall southwest of Galveston on September 8, 1900 as a Category 4 hurricane with estimated maximum sustained winds of 138 mph, which would be 145 mph based on the current climate.

Figure 2 shows the modeled wind and storm surge footprints for the 1900 Galveston Hurricane.

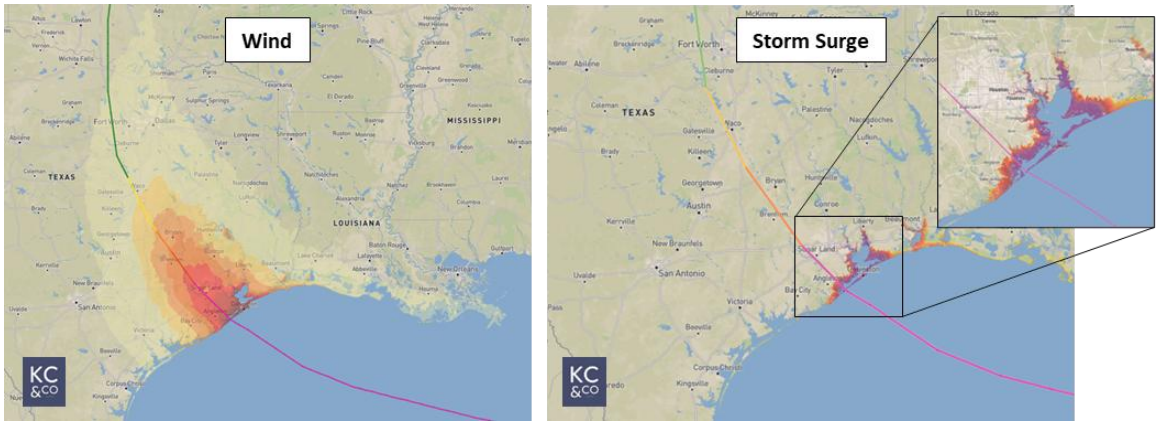



**Figure 2 - Wind (left) and storm surge (right) footprints for the 1900 Galveston Hurricane. The storm surge footprint captures the impact of the Galveston Seawall constructed in 1904.**

The highest wind speeds are along the coast near the landfall point on the southwest end of Galveston Island. The landfall location puts Galveston Island and the city of Galveston in the zone of maximum winds.

Hurricane force winds from a recurrence of this storm would reach 130 miles inland. Tropical storm-force winds would impact about 60,000 square miles, extending through Dallas and as far north as Oklahoma.

Similarly, the peak storm surge occurred near and to the right of the landfall point, with decreasing surge heights moving outward from the center of the storm. Storm surge peaked at 20 feet and most of Galveston Island and port cities around Galveston Bay were inundated with more than 15 feet. More moderate surge of about four feet impacted Freeport to the southwest. The Galveston Seawall–which reaches up to 17 feet above sea level—was built in response to this event; however storm surge from the climate-conditioned scenario would likely overtop the seawall.

These modeled footprints serve as an illustrative representation of the wind speeds and storm surge from the 1900 Galveston Hurricane. While direct instrumental observations from 1900 are limited, the spatial patterns of intensity are consistent with historical accounts of this storm.

## II.C. Vulnerability Module

The Vulnerability Module represents the relationship between intensity and the resulting damage to property. The Vulnerability Module incorporates thousands of vulnerability functions reflecting differences in construction, occupancy, age of structure, region, and other property-specific characteristics.

Vulnerability functions are developed based on multiple sources of engineering knowledge and empirical evidence. These sources include engineering literature, experimental testing, and post-event damage observations. The development of the wind vulnerability functions draws on the scientific and engineering literature on wind effects and structural performance. Foundational work in wind engineering, including studies of aerodynamic loading, pressure distributions, and structural response, informs the representation of wind forces acting on buildings. These principles are incorporated in widely

used standards and guidelines and form the basis for translating wind intensity into structural demand, namely wind pressures, on building systems.

KCC engineers utilize the component method to develop the building vulnerability functions. In this method, a building is assumed to be composed of many components that have distinct damage modes, such as the roof covering, openings, and roof-to-wall connections, as shown in the figure below.

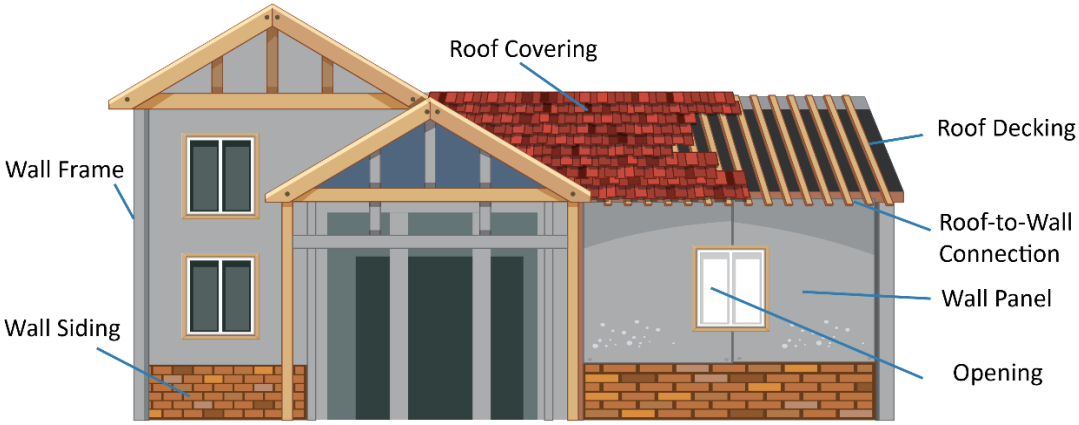



**Figure 3 - Example building components in a typical single-family home**

To quantify the probability of component failure under different wind conditions, KCC engineers rely on wind-loading information from wind tunnel aerodynamic databases. In these experiments, the pressure from a specified wind speed exerted on each plane of a building is recorded on a high-resolution grid for the duration of the experiment. The time series of pressure coefficients is then applied in the development of a probability distribution function (PDF) of wind loading utilizing the methodology described in Sadek and Simiu. Wind tunnel data incorporate various configurations, including different roof geometries and number of stories, and provide information about many building components and characteristics.

The vulnerability function for each individual component is computed by combining the probabilities of failure due to direct and progressive failure. Direct damage results from wind loading and the capacity/resistance of a building component to wind loading, such as roof covering pulling away from the decking. Progressive damage occurs as a result of damage to other building components, such as water infiltration from a broken window or damaged roof covering.

The individual component vulnerability functions are weighted and combined to produce the vulnerability function for the entire building structure. The component weights consider the dependency of the component on other systems, the importance of individual components to a building's performance, and the exposure share of each component. The following illustrates the component method.

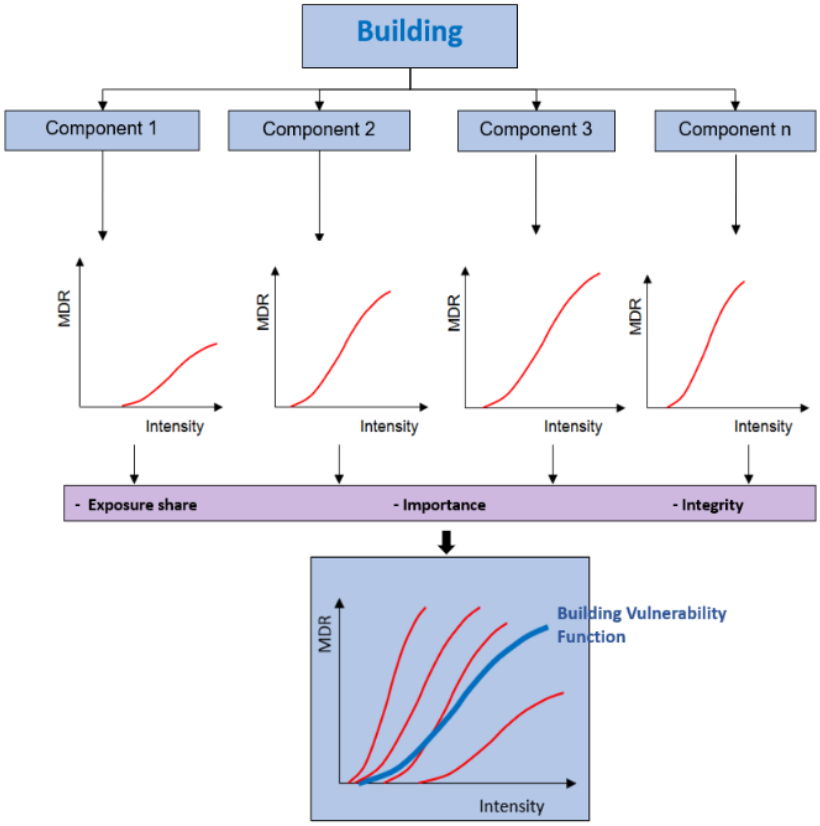



**Figure 4 - Building vulnerability function development with the component method**

Building vulnerability depends not only on physical loading mechanisms but also on how design standards are translated into construction practice. Building codes play a central role by defining minimum design wind speeds, load calculation methodologies, and performance requirements for structural and envelope systems. Codes also refer to testing and certification standards that govern how components must perform when subjected to wind pressures and windborne debris impacts.

Differences in building codes are incorporated into the vulnerability functions through resistance parameters for individual building components. For example, higher prescribed design wind speeds correspond to increased structural capacity, while requirements for impact testing and certification of envelope components translate into higher resistance to windborne debris and reduced probability of failure at a given wind speed. In this way, differences in building codes are systematically incorporated into vulnerability functions through the component-level resistance parameters.

In practice, there can be substantial variation between nominal code requirements and actual construction quality due to differences in enforcement and local building practices. To capture these effects, the vulnerability functions incorporate measures of both building code effectiveness and adoption prevalence. Community-level assessments such as the Building Code Effectiveness Grading Schedule (BCEGS), along with state-level evaluations by organizations such as the Insurance Institute for Business & Home Safety (IBHS), provide insights into how consistently codes are adopted and enforced across jurisdictions.

The influence of building codes on vulnerability is captured through year-built bands, which reflect the temporal evolution of design standards and construction practices. As building codes are updated to

incorporate advances in wind engineering, testing standards, and design methodologies, the expected performance of buildings constructed under those code changes accordingly. By grouping buildings into construction-era bands aligned with major code changes, vulnerability functions account for these time-dependent differences in expected performance.

The vulnerability functions provide estimates of the mean damage in response to one-minute sustained wind speeds experienced at a location. For each structure type, there are four vulnerability functions representing the mean damage ratios (MDRs) for building, appurtenant structure, contents, and time element losses.

### II.D. Financial Module

The Financial Module translates modeled physical damage into property losses by applying the MDRs to the estimated replacement costs of structures and their contents.

To calculate losses for hurricane events, KCC engineers leverage the KCC Property Replacement Cost (PRC) database. For every five-digit ZIP code, the PRC includes the number of properties and their replacement costs, including single-family homes (SFH), apartment buildings, and all types of commercial and industrial structures. This information is derived from multiple sources, including census data, labor statistics, construction patterns, and location-level building attribute data. KCC scientists utilize the PRC to estimate the losses of structures impacted by an event.

# III. Property Data Analysis

Over the past 35 years, the Galveston/Houston area has seen some of the largest increases in population and property value in total value of property. The growing concentration of properties along the coast significantly increases the risk of hurricane impacts. In addition to more structures exposed to hurricane risk, the average size of new homes has increased since 1990, and the cost per square foot to repair or replace a home has increased significantly.

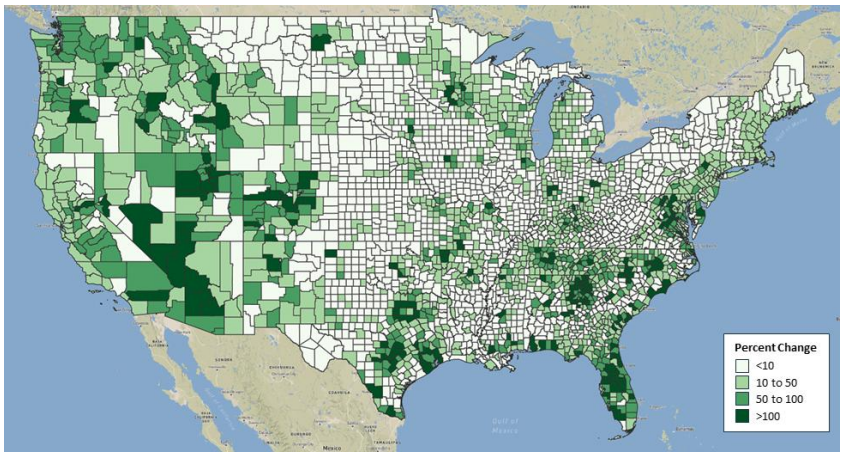



**Figure 5 - Percent change in U.S. population by county from 1990 to 2025**

Construction cost increases generally outpace the rate of inflation, and the COVID-induced supply shortages caused housing costs to skyrocket over the past several years. The cost of building the same SFH has risen significantly over the past decade and by 240% since 1990.

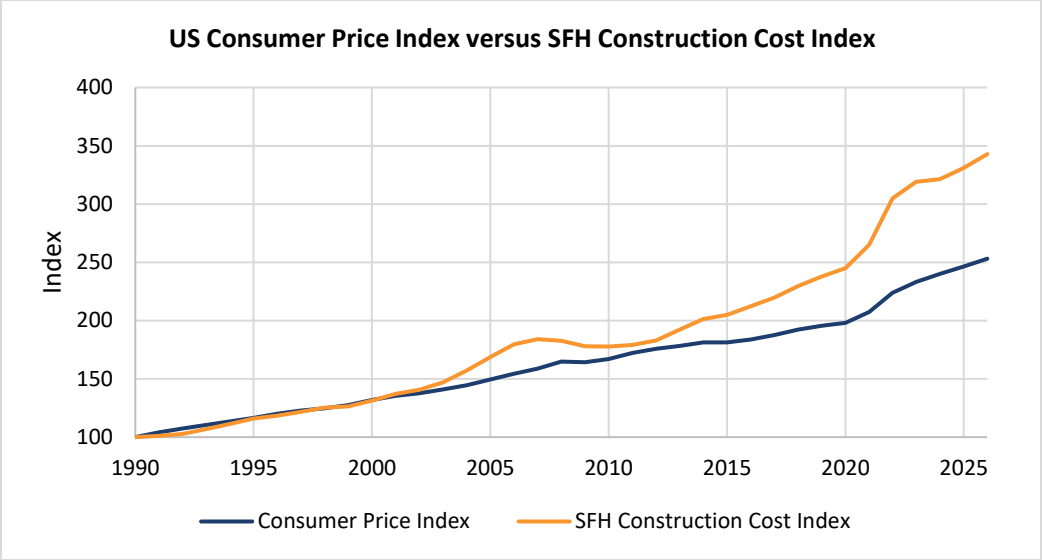



**Figure 6 - U.S. Consumer Price Index versus SFH Construction Cost Index from 1990 to 2025. Indexes are normalized to 100 in 1990 (Sources: CPI – Bureau of Labor Statistics, CCI – U.S. Census, Craftsman's 2026 National Building Cost Manual, and 2026 RSMeans.)**

When all of these factors are combined, the total property value along the coast and immediately inland (Tier 1 and 2 counties) has increased from less than $10 trillion in 1990 to over $30 trillion in 2025.




**Figure 7 - Estimated residential, commercial, and industrial replacement costs in 1990 versus 2025 for the first two tiers of coastal counties**

With the combination of increased exposure, higher construction costs, and climate change, the 1900 Galveston Hurricane would cause over $168 billion in property damage across all states if it were to occur today with the existing building stock—of that total, $88 billion would be to SFH in Texas.

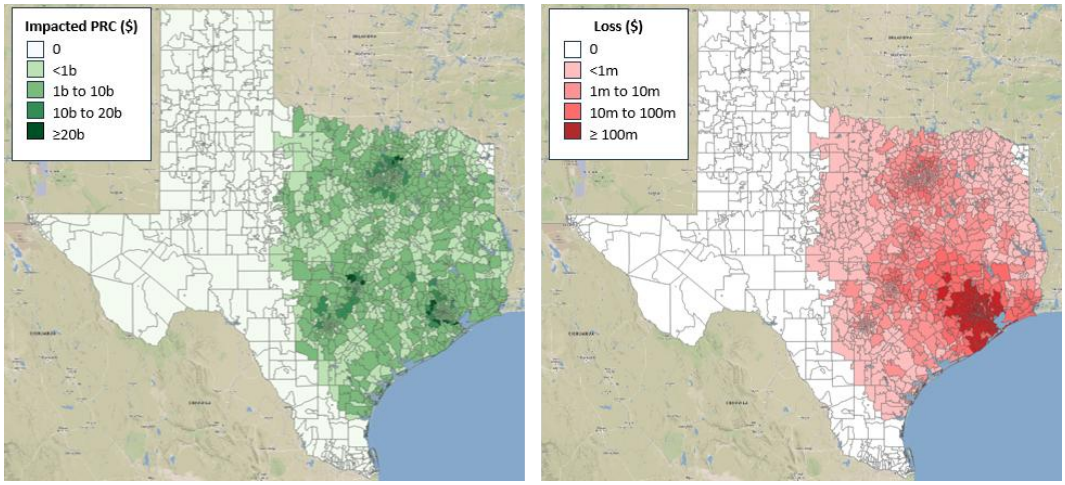



**Figure 8 - Impacted SFH PRC in Texas within the 1900 Galveston Hurricane wind footprint (left) and losses from the hurricane if it were to recur with today's climate and exposure (right)**

# IV. How Building Codes Have Responded to Increasing Exposure to Weather and Extreme Events

Building codes in the U.S. have evolved substantially since the early 1900s when building regulations were first developed. Over time, three major regional organizations emerged to provide building codes tailored to different parts of the country.

- Building Officials and Code Administrators (BOCA), founded in 1915, served the Northeast and Midwest and published the BOCA Building Code.
- The International Conference of Building Officials (ICBO), founded in 1922, was adopted in the Western U.S. and published the Uniform Building Code (UBC).
- The Southern Building Code Congress International (SBCCI), founded in 1940, published the Standard Building Code—preferred in the Southeastern U.S..

Because these regional codes evolved largely independently, their treatment of wind loads reflected both regional hazard characteristics and differences in engineering practices. Coastal and hurricane-prone regions, particularly in the Southeast under SBC, gradually incorporated more explicit consideration of wind effects, while other regions placed comparatively less emphasis on wind as a governing design load.

Hurricane Andrew in 1992 exposed major weaknesses in residential building envelopes, including roof sheathing attachment, opening protection, garage doors, soffits, and cladding systems. In response, the 1995 and 1997 SBC editions emphasized continuous load paths, envelope integrity, and windborne-debris resistance.

Efforts to harmonize building regulations in the 1990s culminated in the consolidation of the regional code bodies into the International Code Council (ICC), which introduced a unified family of model codes in 2000, known as the I-codes. The I-codes include the International Residential Code (IRC), which integrated modern wind design practices based on standards such as the American Society of Civil Engineers (ASCE) Minimum Design Loads and Associated Criteria for Buildings and Other Structures (ASCE 7).

The I-codes are fundamentally hazard-based design systems. In the context of wind design, this means that the required building performance is explicitly tied to the intensity of the wind hazard at a given location.

The 2000 and 2003 IRC versions provided a national residential code structure, addressing roof coverings, exterior wall coverings, water-resistive barriers, and openings through relatively broad prescriptive requirements rather than the more detailed wind-specific provisions found in later editions. For example, windborne debris protection provisions permitted predefined wood structural panel systems with specified fastening schedules and attachment details for protecting glazed openings in hurricane-prone regions.

In 2012, significant updates were made to the IRC, including updated ASCE 7 wind maps, formal Windborne-Debris Region (WBDR) definitions, component-and-cladding pressures, and product-specific testing standards. The 2012 code also distinguished between different failure modes: wind pressure, windborne-debris impact, water intrusion, and cladding detachment. Opening protection evolved into a more explicit system of exterior glazing protection in the WBDR. Roof deck and roof covering provisions became more closely tied to uplift resistance, attachment schedules, and product standards. Wall siding and exterior wall covering provisions also became more material-specific, with increasing reliance on product approvals, design pressure ratings, and installation requirements.

The 2021 IRC reflects a more mature component-level framework, with clearer pressure-based treatment for elements such as garage doors, exterior glazing, roof and wall cladding, and related envelope components. Additionally, the 2021 IRC adopted an updated wind framework that aligned with newer ASCE 7-16 wind data. Figure 9 shows the ASCE 7 design wind speed map, which specifies the three-second gust wind speeds that buildings should be designed to resist.

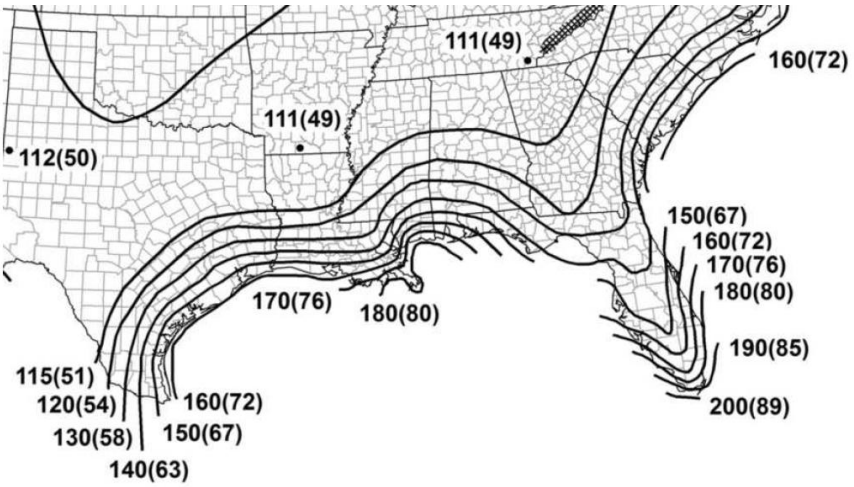



**Figure 9 - ASCE 7-16 Risk Category II design wind speed map for the Gulf and Southeast coasts. Wind speeds are provided in mph, with m/s in parentheses. Source: ASCE 7-16**

The table in Appendix A summarizes the evolution of selected wind-related residential building provisions from late SBC-era construction through the 2021 IRC.

State legislation determines whether the I-codes are adopted, to what degree, and how frequently they are updated (typically every three to six years). This legislation generally covers one of three options:

- **Statewide and Enforced Code:** State adopts and updates codes at the state level
- **Statewide Code without Uniform Enforcement:** Statewide code framework exists but local jurisdictions retain significant authority over adoption, amendments, implementation, and enforcement.
- **No Statewide Code:** Building code adoption occurs at the local level with no statewide framework.

For example, Florida enacted legislation in 1998 to create a centralized building code framework for the state that is administered by the Florida Building Commission and updated on a three-year cycle. Such a legislative framework produces a relatively uniform statewide code regime.

In contrast, Texas follows a "home rule" approach in which local jurisdictions retain substantial authority over code adoption and updating. Texas requires a baseline of meeting IRC 2012 for residential buildings in cities, but there is no such requirement for unincorporated areas. As a result, there is large variation in the status of code adoption, adoption timelines, and enforcement stringency across local jurisdictions.

The following map shows whether each state has adopted and enforced IRC, as of 2026.

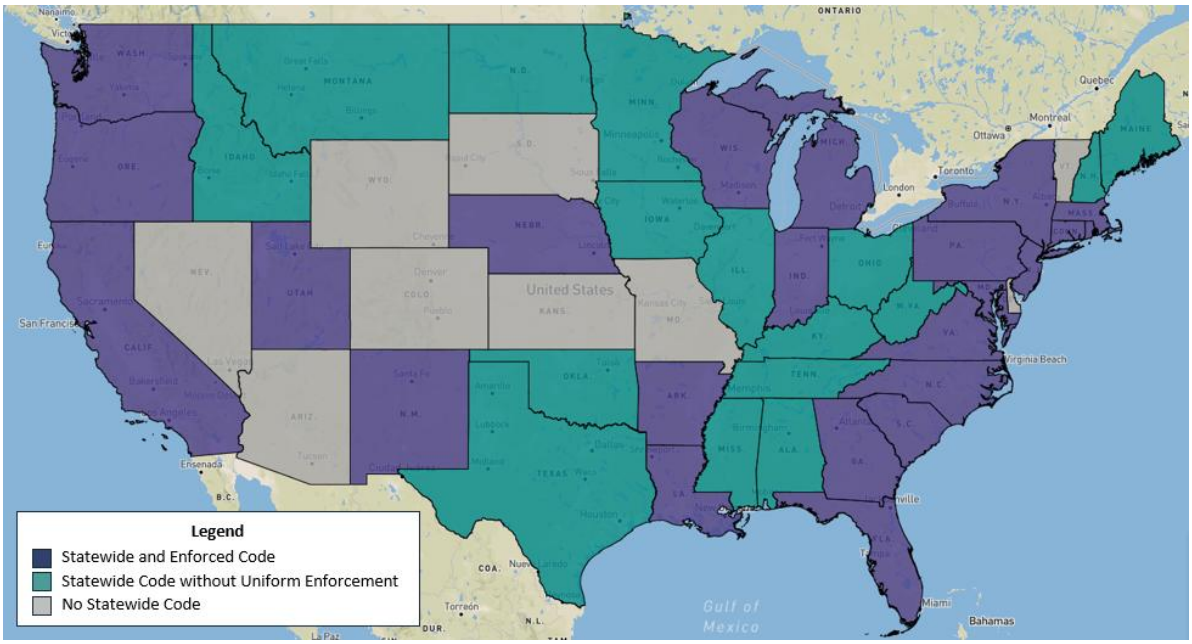



**Figure 10 - Current status of statewide adoption of IRC**

## IV.A. Texas Building Code

As a home-rule state, Texas does not operate with a unified building code and relies primarily on local adoption of model building codes by municipalities. Texas statutes require incorporated municipalities to adopt, at a minimum, the 2012 I-codes, with the option to adopt newer editions of codes or local amendments.

However, this mandate does not apply to unincorporated areas. While the majority of the population currently resides in incorporated municipalities, these areas represent only a small geographic area of the state and the population of unincorporated areas is growing rapidly. These variations in requirements result in substantial variation in building codes across jurisdictions exposed to similar hurricane hazard levels.

Additionally, the code adoption and enforcement consistency in Texas are relatively low, as there is no statewide licensing program for building officials. Even when model technical standards are available, the likelihood that buildings are designed, permitted, inspected, and constructed in accordance with those standards depends heavily on local adoption, local amendments, and inspection capacity. A significant majority of the unincorporated areas have not adopted a residential code or requirements for inspection of new roofs. Many jurisdictions also rely on builder-submitted inspection reports, without third-party oversight.

From a vulnerability perspective, this governance structure indicates that buildings constructed under similar wind hazard conditions may exhibit materially different resistance characteristics depending on jurisdiction, construction date, and local enforcement practices. The KCC Hurricane Model Vulnerability Module captures the effects of limited code adoption and enforcement in Texas through lower resistance parameters for individual building components such as roof systems and building openings. In addition, the less prevalent use of impact-rated window protection in Texas relative to states like Florida that have stringent opening protection requirements is captured in the Vulnerability Module through higher vulnerability to windborne debris.

Post-event surveys conducted by KCC engineers after Hurricane Harvey (2017) revealed wind-related vulnerabilities in the building stock, including failures of roof coverings, damage to roof-to-wall connections and breaches of building envelopes. Overall, the observed performance suggests that building practices align with the model assumptions. In areas categorized as WBDR after the 2012 I-codes change, many buildings did not have adequate opening protection as required under the 2012 IRC. Progressive damage modes that may have been alleviated by meeting minimum requirements in IRC 2012 were observed in buildings constructed after the code was published. As a result, Texas buildings are modeled with higher vulnerability at equivalent wind speeds compared to states with statewide mandatory building codes.

# V. Part 1: Quantifying Hurricane Loss Reduction for Different Hypothetical Scenarios

To quantify the impact of more stringent wind-resistant construction standards, a hypothetical model experiment was conducted to estimate the reduction in losses that would occur if portions of the coastal Texas SFH building stock were constructed according to the standards stipulated in the prevailing building code (SBC or IRC) corresponding to the building's year of construction.

The 1900 Galveston Hurricane was selected as the test event due to its historical significance as one of the most severe wind catastrophes affecting what is now one of the most populated areas along the Gulf Coast and an area highly prone to major hurricanes.

## V.A. Testing Scenarios

As a baseline, KCC estimated the impact of the climate-conditioned 1900 Galveston Hurricane if it were to recur with the current building inventory. The spatial extent and intensity of the modeled wind footprint provide the hazard basis for the study, allowing the impact of alternative building vulnerability assumptions to be assessed under identical wind conditions.

The baseline exposure for the study was constructed using PRC exposure totals for SFH aggregated at the ZIP code level, which were then distributed across year-built bands according to their relative proportions within the Texas building inventory based on the most recent U.S. Census and American Community Survey housing data. This approach preserves the spatial distribution of current property values while allowing vulnerability assumptions to vary according to construction year, reflecting the fact that building practices and code requirements have evolved over time.

Figure 11 shows the proportion of SFHs built in 1995 and later, 2000 and later, and 2012 and later by county. The selected years correspond to major shifts in residential wind design standards: the post-Hurricane Andrew SBC updates (mid-1990s), the introduction of the IRC (2000), and the revision of WBDR requirements (2012).

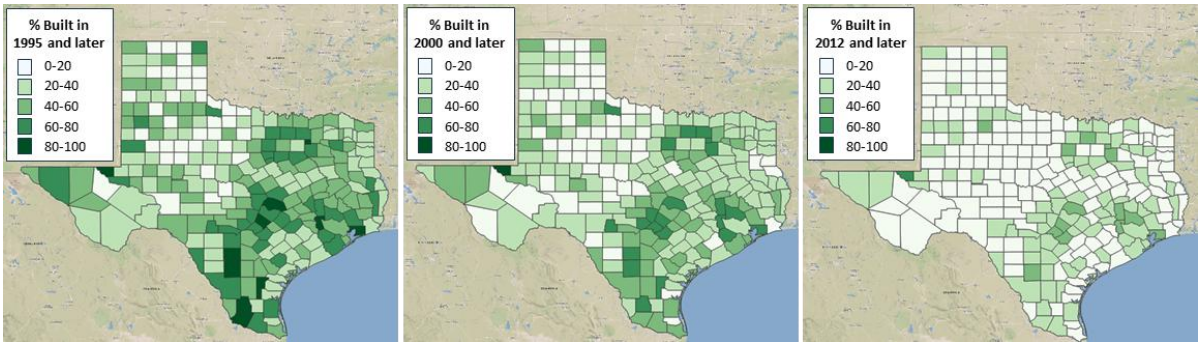



**Figure 11 - Proportion of SFHs within each county that were built in 1995 and later (left), 2000 and later (middle), and 2012 and later (right)**

Four hypothetical upgrade scenarios were evaluated to estimate how loss outcomes would change if the building inventory in Tier 1 and Tier 2 counties were built under the concurrent building code for comparable wind speed regimes and construction periods. These counties were selected because of the high risk and high exposure along the coast. Figure 12 shows the counties that were upgraded:

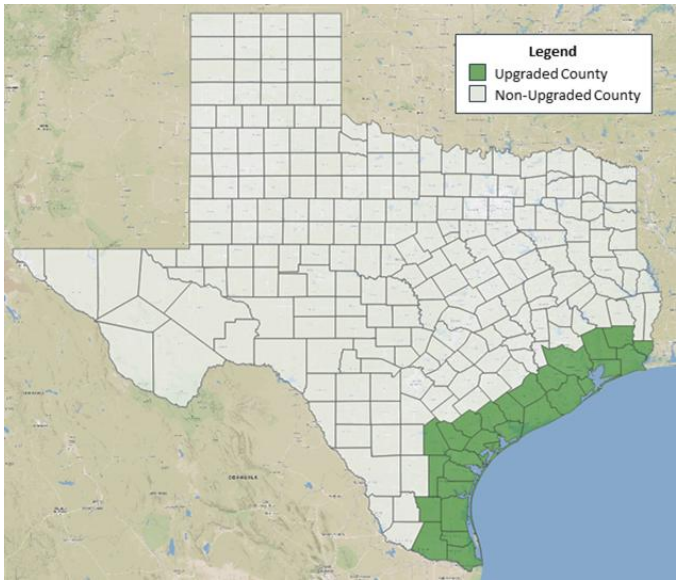



**Figure 12 - Tier 1 and 2 counties utilized for test scenarios**

**Scenario 1** represents a theoretical upper bound in which all SFHs within the upgraded counties were constructed according to the most recent building code during the year they were built. This scenario effectively assumes that the entire coastal building inventory benefits from the most up-to-date construction practices.

**Scenario 2** represents a partial transition scenario. In this case, only buildings constructed in or after 1995 within the upgraded counties were assigned to their concurrent edition of the SBC or IRC. Buildings constructed between 1995 and 2000 are assumed to be built using the corresponding year of SBC and buildings after 2000 are assumed to meet the standards in the corresponding year of IRC. Under this scenario, approximately **40% of the PRC** within these counties was upgraded.

**Scenario 3** represents a transition assumption in which only buildings constructed after 2000 are assumed to meet the IRC. This corresponds roughly to the period following major advances in hurricane engineering and building code modernization in many jurisdictions. The formation of the ICC and the publication of the first IRC also occurred in 2000. Under this scenario, approximately **30% of the PRC** within the study region was upgraded.

**Scenario 4** represents a case where only the newest building stock, i.e., those constructed in or after 2012, are upgraded to the most recent building code during the year they were built. This period corresponds to the major IRC update of 2012. Under this scenario, approximately **16% of the PRC** within the study region was upgraded.

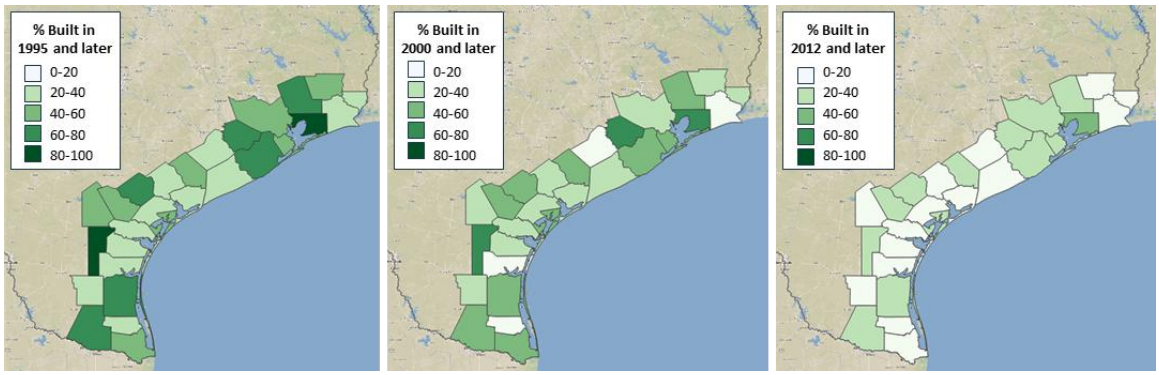



**Figure 13 - Proportion of buildings upgraded in scenario 2 (left), 3 (middle), and 4 (right)**

## V.B. Results

The results of the testing scenarios quantify how differences in building code adoption translate into reduced hurricane losses under consistent hazard conditions. Applying the 1900 Galveston Hurricane to the current building inventory and climate assumptions shows that a recurrence would produce widespread impacts. More than 60 million people would be exposed to at least tropical storm-force winds, including over seven million people exposed to hurricane-force wind speeds. In total, over $10 trillion of PRC would fall within the storm's footprint, nearly half of which consists of SFHs.

Table 1 summarizes the modeled SFH losses from the climate-conditioned 1900 Galveston Hurricane under the baseline and the four building code upgrade scenarios.

| | Loss ($ Billions) | Reduction ($ Billions) | Reduction (%) |
|---|---|---|---|
| **Baseline** | 88.54 | | |
| **Scenario 1** | 49.38 | -39.16 | -44 |
| **Scenario 2** | 71.27 | -17.27 | -20 |
| **Scenario 3** | 75.88 | -12.66 | -14 |
| **Scenario 4** | 82.61 | -5.93 | -7 |

**Table 1 - Estimated losses for SFHs in Texas from baseline and test scenarios**

Under **Scenario 1**, where all locations in the upgraded counties are assumed to have been constructed according to the most recent building code during the year they were built, total losses decrease to approximately $49 billion, representing a reduction of about $39 billion (44%) relative to the baseline. This represents the theoretical upper bound of loss reduction under the assumptions of this study. The magnitude of this reduction underscores the degree to which improved building codes can reduce loss outcomes for extreme wind events.

Even under **Scenario 4**, where only newer construction (≥ 2012) was assumed to meet the latest building code, the total loss decreases by nearly $6 billion, indicating that improvements to even a small proportion of the PRC can result in significant benefits.

Taken together, the results demonstrate a consistent relationship between enhanced building codes and reduced hurricane losses. Larger proportions of upgraded exposure yield correspondingly greater reductions, yet even limited upgrades confined to recent construction vintages lead to significant decreases in property loss. These findings suggest that incremental improvements in wind-resistant construction can materially reshape the loss profile of severe hurricanes.

# VI. Part 2: Quantifying the Costs versus Benefits of Building Code Adoption

In the first part of this study, the objective was to illustrate the benefits of building codes in terms of reducing aggregate hurricane losses. In this second part, the objective is to determine the benefit-cost ratio of building to stronger building codes. Benefits refer to the present value of avoided annual expected losses from hurricanes over the duration of a building's life. Costs refer to the additional upfront cost incurred for a new building to meet the wind provisions of specific building codes.

IRC 2000 and IRC 2021 were chosen as code benchmarks to evaluate the benefits and costs. IRC 2000 was a milestone code in the U.S. that transitioned separate regional codes to a more unified model code and IRC 2021 is the most recent building code with widespread adoption. While there is a newer released code—IRC 2024—it will take several years for it to be adopted widely.

The KCC Hurricane Model was leveraged to determine the expected annual hurricane losses for a typical SFH for various selected locations. Six locations in coastal Texas were selected to represent a gradation in design wind speed per ASCE 7-16. Galveston, the city closest to the coast, has the highest design wind speed of 150 mph, with design wind speed decreasing farther inland. Huntsville, the farthest inland location, has the lowest design wind speed of 115 mph. The six locations, along with the design wind speeds, are shown in Figure 14.

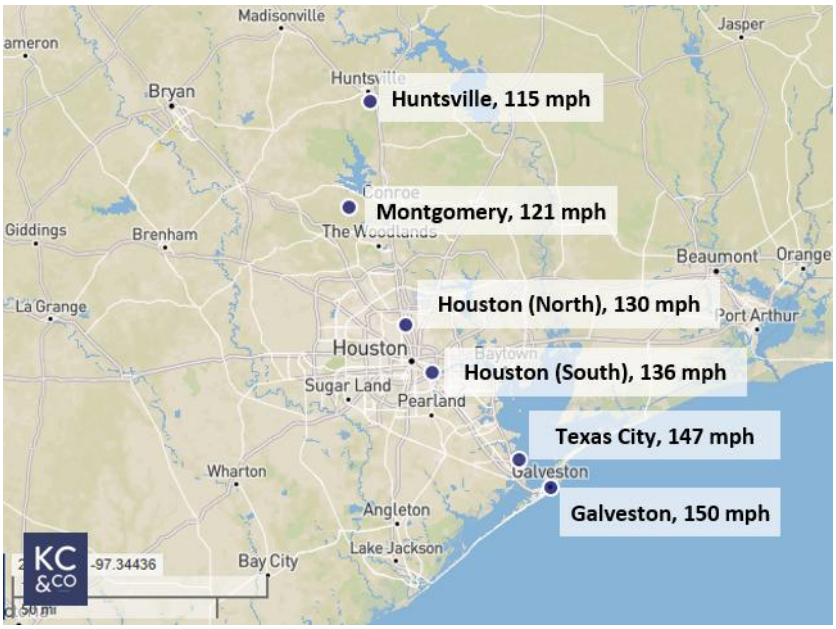



**Figure 14 - Locations and design wind speeds selected for benefit-cost analysis**

To represent the vulnerability differences attributable to code upgrades, each location was assigned three SFHs with different design standards:

1. **No Code Baseline**: This SFH serves as a baseline to calculate the benefits of upgrading to different codes. The vulnerability function for this building was developed assuming component resistances associated with current building practice in Texas.
2. **IRC 2000**: This SFH is designed to meet the wind provisions in IRC 2000.
3. **IRC 2021:** This SFH is designed to meet the wind provisions in IRC 2021.

The No Code Baseline building in all six locations is assumed to have the same vulnerability to produce a consistent baseline. This is a reasonable assumption because under no code, construction of a typical single-family home follows relatively similar practices across coastal Texas.

However, the IRC 2000 and IRC 2021 buildings have different requirements for each location based on the distance from the coast. From this perspective, there are three different design zones (DZ), as shown in the figure below.

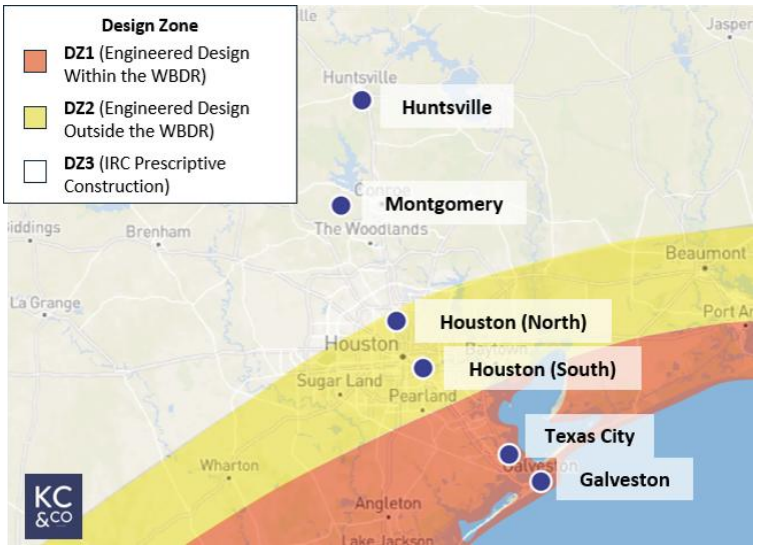



**Figure 15 - Three design zones under IRC**

- **DZ1: Engineered Design Within the WBDR** requires homes to be designed using a site-specific engineered wind design and to comply with additional code provisions for protection against windborne debris, such as impact-resistance glazing and shutters. The WBDR includes hurricane-prone areas with ultimate design wind speeds of 140 mph or greater, shown in orange in Figure 15. Galveston and Texas City fall within this design zone.
- **DZ2: Engineered Design Outside the WBDR** requires homes to be designed using a site-specific engineered wind design (where components for wind resistance are determined by engineering calculations instead of IRC prescriptive provisions) but does not include the additional wind-borne debris requirements that apply within the WBDR. This zone includes areas with ultimate design wind speeds generally greater than 130 mph where the IRC prescriptive

provisions are not applicable and an engineered wind design is required. Houston (South) and Houston (North) fall in this zone, shown in yellow in Figure 15.

- **DZ3: IRC Prescriptive Construction** requires homes to be designed in accordance with the IRC prescriptive provisions (where wind resistance is achieved through code-prescribed fastening schedules, roof-to-wall connections, and other standardized construction details rather than site-specific engineering calculations). These areas are generally associated with lower design wind speeds and therefore do not require a site-specific engineered wind design. This zone is outside the yellow and red regions identified in the IRC design wind speed map in Figure 15. Locations in Montgomery and Huntsville fall in this zone.

The KCC Hurricane Model was employed to estimate the average annual losses (AALs) for the three SFHs in the six locations. A typical one-story wood-frame home was assumed to have a $500,000 replacement cost before upgrades.

The table below shows the AALs for each test SFH. As expected, the AAL is highest in Galveston and decreases for inland areas, and the AALs are highest for the No Code Baseline case.

| Area Name | Design Building Code | AAL ($) |
|---|---|---|
| **Galveston** | No Code Baseline | 8,480 |
| | IRC 2000 | 4,259 |
| | IRC 2021 | 2,104 |
| **Texas City** | No Code Baseline | 5,762 |
| | IRC 2000 | 2,790 |
| | IRC 2021 | 1,265 |
| **Houston (South)** | No Code Baseline | 1,151 |
| | IRC 2000 | 506 |
| | IRC 2021 | 215 |
| **Houston (North)** | No Code Baseline | 1,091 |
| | IRC 2000 | 479 |
| | IRC 2021 | 203 |
| **Montgomery** | No Code Baseline | 541 |
| | IRC 2000 | 339 |
| | IRC 2021 | 132 |
| **Huntsville** | No Code Baseline | 227 |
| | IRC 2000 | 142 |
| | IRC 2021 | 56 |

**Table 2 - AAL for the eighteen test SFHs**

## VI.A. Cost Calculation

The cost estimates were developed using a component-based approach in which individual wind-resistance requirements were translated into specific construction upgrades and associated cost increases. These upgrade costs include stronger materials, fastening schedules, connection details, structural bracing, and opening protection, as applicable to each code edition and selected locations. Table 3 and Table 4 summarize the estimated cost increases for IRC 2000 and IRC 2021, respectively, under each of the six locations. Note: upgrades for IRC 2021 generally correspond to higher rated products or stronger designs. The following discussion of wind-borne debris protection illustrates how costs were estimated to reflect upgrade options and construction requirements.

Within the Wind-Borne Debris Region (WBDR), exterior glazed openings must be protected with impact-resistant glazing or approved protective coverings. According to the technical reports from Home Innovation Research Labs, the lower end of the cost range (0.8 percent, or approximately $4,000 for a $500,000 home) represents wood-panel-based protection systems. Intermediate costs are associated with steel or aluminum panel and shutter systems. The upper end (2.5 percent, or approximately $12,500) represents impact-resistant glazing systems that require laminated glass and reinforced framing.

| Component | Upgrade | DZ1 | | DZ2 | | DZ3 | |
|---|---|---|---|---|---|---|---|
| | | Galveston | Texas City | Houston (South) | Houston (North) | Montgomery | Huntsville |
| **Roof Covering** | Rated shingles | 0.6 | 0.6 | 0.5 | 0.5 | - | - |
| **Underlayment** | Thicker underlayment with denser fastening | 0.4 | 0.4 | 0.4 | 0.4 | 0.3 | 0.3 |
| **Roof Deck** | Tighter nailing and/or heavier sheathing | 1.1 | 1.1 | 1 | 0.9 | 0.2 | 0.18 |
| **Roof-to-Wall Connections** | Stronger connections | 0.5 | 0.5 | 0.4 | 0.38 | 0.2 | 0.18 |
| **Openings** | Higher design pressure ratings | 0.6 | 0.6 | 0.5 | 0.5 | - | - |
| **WBDR Protections** | Impact-rated glazing or shutters | 0.8-2.5 | 0.8-2.5 | - | - | - | - |
| **Walls** | Braced walls and wood structural panels | 0.5 | 0.5 | 0.4 | 0.4 | 0.2 | 0.2 |
| **Total** | | 4.5-6.2 | 4.5-6.2 | 3.2 | 3.08 | 0.9 | 0.86 |

**Table 3 - Summary of estimated percent cost increases for SFH components constructed according to IRC 2000 compared to no code baseline in the six locations.**

| Component | Upgrade | DZ1 | | DZ2 | | DZ3 | |
|---|---|---|---|---|---|---|---|
| | | Galveston | Texas City | Houston (South) | Houston (North) | Montgomery | Huntsville |
| **Roof Covering** | Rated shingles | 0.8 | 0.8 | 0.7 | 0.7 | 0.3 | 0.3 |
| **Underlayment** | Thicker underlayment with denser fastening | 0.5 | 0.5 | 0.5 | 0.5 | 0.3 | 0.3 |
| **Roof Deck** | Tighter nailing and/or heavier sheathing | 1.3 | 1.3 | 1.2 | 1.1 | 0.5 | 0.46 |
| **Roof-to-Wall Connections** | Stronger connections | 0.6 | 0.6 | 0.5 | 0.47 | 0.2 | 0.18 |
| **Openings** | Higher design pressure ratings | 1.1 | 1.1 | 1 | 1 | 0.4 | 0.4 |
| **WBDR Protections** | Impact-rated glazing or shutters | 0.8-2.5 | 0.8-2.5 | - | - | - | - |
| **Walls** | Braced walls and wood structural panels | 0.7 | 0.7 | 0.6 | 0.6 | 0.3 | 0.3 |
| **Total** | | 5.8-7.5 | 5.8-7.5 | 4.5 | 4.37 | 2 | 1.94 |

**Table 4 - Summary of estimated percent cost increases for SFH components constructed according to IRC 2021 compared to no code baseline in the six locations.**

## VI.B. Benefit Calculation

The benefits are calculated as the annual reduction in AAL over the life of each SFH. The AAL is increased at a rate of five percent per year to recognize the historical annual average construction cost increase. Rises in construction costs increase the benefits since the reductions in property losses are calculated as percentages of the replacement costs.

A 30-year service life was assumed for this study. Although residential buildings often remain in service for longer periods, a 30-year analysis period was selected to represent a practical period over which building code improvements are expected to generate meaningful benefits. The 30-year period is also broadly consistent with the duration of a typical residential mortgage, making the results relevant to homeowners, lenders, and policymakers.

A discount rate of 4.25% was selected to convert future avoided losses to present value terms. This rate is the historical long-term average 10-year U.S. treasury yield.

## VI.C. Benefit-Cost Analysis Results

The benefit-cost ratio (BCR) results for each location and upgrade scenario are shown in the following tables. The first table shows the results when building upgrades are made from No Code Baseline to IRC 2000. The second table shows the results for upgrading from No Code Baseline to IRC 2021.

| Metric | Galveston | Texas City | Houston (South) | Houston (North) | Montgomery | Huntsville |
|---|---|---|---|---|---|---|
| **Additional Cost (% of PRC)** | 5.40 | 5.40 | 3.20 | 3.08 | 0.9 | 0.86 |
| **Annual Benefit ($)** | 4,221 | 2,790 | 644 | 621 | 202 | 85 |
| **Present Value Benefit ($)** | 135,021 | 95,097 | 20,612 | 19,589 | 6,453 | 2,732 |
| **Cost of Upgrades (S)** | 27,000 | 27,000 | 16,000 | 15,400 | 4,500 | 4,300 |
| **BCR** | **5.00** | **3.52** | **1.29** | **1.27** | **1.43** | **0.64** |

**Table 5 - Benefit-cost analysis results of upgrading a SFH from No Code to IRC 2000**

| Metric | Galveston | Texas City | Houston (South) | Houston (North) | Montgomery | Huntsville |
|---|---|---|---|---|---|---|
| **Additional Cost (% of PRC)** | 6.65 | 6.65 | 4.5 | 4.37 | 2.0 | 1.94 |
| **Annual Benefit ($)** | 6,409 | 1,577 | 936 | 889 | 409 | 172 |
| **Present Value Benefit ($)** | 203,981 | 143,873 | 29,946 | 28,427 | 13,081 | 5,492 |
| **Cost of Upgrades ($)** | 33,250 | 33,250 | 22,500 | 21,850 | 10,000 | 9,700 |
| **BCR** | **6.13** | **4.33** | **1.33** | **1.30** | **1.31** | **0.57** |

**Table 6 - Benefit-cost analysis results of upgrading a SFH from No Code to IRC 2021**

As expected, the BCR is highest along the coast at the Galveston location and generally decreases as you move inland. Interestingly, the BCRs are generally higher for IRC 2021 versus IRC 2000, illustrating that the additional costs of IRC 2021 are in most cases outweighed by the additional benefits.

The Montgomery location, in DZ3, has a relatively higher BCR than Houston despite being further inland because the upgrade costs to meet code are significantly lower than locations in DZ1 and DZ2. Recall that locations in DZ3 are only required to follow prescriptive design requirements. Hence, no added requirement of extreme wind resistant components enter the cost calculation for this location. However, hurricane losses are still significant enough in this location to generate meaningful benefits from stronger construction.

On the other hand, the low BCR in the Huntsville location shows that there is some level of hurricane risk below which building code upgrade costs begin to outweigh benefits. This result reinforces that stronger building codes are most cost-effective in areas with greatest hurricane risk.

### VI.C.1. Benefits Beyond Direct Hurricane Property Loss Reduction

In addition to the calculated benefits, consumers would likely see additional savings on their homeowners premiums. The reduction in AALs would flow directly into the premium calculation and there would be additional savings from insurer costs that are calculated as percentages of premiums such as agent commissions. Those savings are not included in the results of the study.

Stronger building codes may also reduce losses from severe convective storms (SCS). Many of the same code provisions that reduce hurricane losses, such as stronger roof systems, enhanced roof-to-wall connections, and improved opening protection, also reduce vulnerability to SCS damage. This additional benefit is important because SCS generally generates higher annual insured losses than hurricanes. Potential reductions in SCS losses are not included in the benefit-cost results presented in this study.

Stronger building codes also provide broader community benefits. Buildings that sustain less damage are more likely to remain habitable after an event, reducing displacement and recovery costs. Improved building performance can also reduce business interruption, support economic continuity, and accelerate community recovery. Because this study quantifies only direct property loss reduction from hurricanes, the results likely understate the full value of modern building codes.

# VII. Conclusions

The results of this study demonstrate that stronger building codes can generate significant reductions in hurricane losses. The additional costs associated with stronger wind-resistant construction are often small relative to the resulting reduction in expected losses, particularly in high-risk coastal communities.

Interestingly, across most study locations, IRC 2021 produced higher benefit-cost ratios than IRC 2000, indicating that the additional loss reduction achieved by newer code requirements more than offsets the additional construction costs.

Because buildings remain in service for decades, stronger standards incorporated into new construction can gradually reduce vulnerability across the building stock over time. This allows communities to improve resilience without the significant costs and logistical challenges associated with widespread retrofitting of existing structures.

These findings are generally consistent with previous studies that have demonstrated the benefits of modern building codes. What distinguishes this study is the assessment of the benefits and costs across different locations and identifying where more stringent building codes are most impactful. Additionally, this study illustrates the scale of loss reduction that would be experienced in major hurricanes.

The benefit-cost results presented in this study are conservative because they reflect only direct hurricane property loss reductions. Additional benefits, including reductions in severe convective storm losses, lower insurance costs, reduced displacement, and faster community recovery, were not quantified. As a result, the total value of stronger building codes is likely greater than indicated by the modeled results.

Although this analysis focuses on coastal Texas, the relationship between building-code strength and loss reduction is applicable to other hurricane-prone regions with similar hazard characteristics. Florida, for example, has implemented a uniform statewide building code that promotes consistent adoption, updating, and enforcement of modern standards. As coastal populations continue to grow and property replacement costs rise, the amount of property exposed to hurricane risk will continue to increase. As a result, the potential benefits of stronger building standards will also increase over time.

## APPENDIX A: SUMMARY OF SELECTED WIND-RELATED RESIDENTIAL BUILDING PROVISIONS FROM LATE SBC-ERA CONSTRUCTION THROUGH THE 2021 IRC

| Component | 1988 SBC | 1995 SBC | IRC 2000 | IRC 2012 | IRC 2021 |
|---|---|---|---|---|---|
| **Design Wind Speed** | Wind speeds treated as older fastest-mile / ASCE 7-88-era basis, not directly comparable to later ultimate wind speeds. | Replaced older fastest-mile wind maps with more accurate region-specific three-second gust design wind speed maps to better reflect contemporary hurricane risk | Early IRC wind-speed framework using three-second gust wind speeds in prescriptive residential provisions. | The broader ASCE 7-10 wind framework moved to ultimate wind-speed maps, but the 2012 IRC used ASCE 7-10-based data converted back to nominal / ASD-style wind speeds for IRC prescriptive use. | Updated IRC wind framework aligned with newer ASCE 7-16 wind data. |
| **Definition of WBDR** | Component and cladding pressures generally derived through SBC structural wind provisions / ASCE 7-era methods, with less mature envelope-specific prescriptive treatment than later hurricane codes. | *No upgrade* | A common 2000 IRC definition was hurricane-prone regions within 1 mile of coastal mean high-water line at 110 mph or greater, or anywhere wind speed was 120 mph or greater, or Hawaii. | Major change: WBDR is defined through a new map; ICC notes that the definition was revised to delete older wind-speed/proximity text in favor of the new mapped WBDR approach. | *No upgrade* |
| **Roof Covering** | Roof-covering wind resistance existed but pre-Andrew practice did not fully reflect later hurricane roof-covering and water-intrusion lessons. | Refined components & cladding pressure coefficients to better capture localized pressure | Asphalt shingles require special fastening in higher-wind areas; Texas's 2000 IRC revisions show special fastening where basic wind speed is 110 mph or greater and six-fastener triggers at higher wind/eave conditions. | *No upgrade* | More mature wind-resistance classifications by roof-covering type |

| Component | 1988 SBC | 1995 SBC | IRC 2000 | IRC 2012 | IRC 2021 |
|---|---|---|---|---|---|
| **Water Resistive Barriers (WRB)** | Basic weather-resistive exterior wall concepts, but less developed drainage-plane detail than later IRC editions. | *No upgrade* | Baseline IRC WRB and flashing requirements. | *No upgrade* | Drainage-plane / moisture-management improvement: 3/16-inch air space or high-drainage-efficiency material in moist climate zones |
| **Roof Deck** | No special provision | Added new roof sheathing, roof diaphragm, uplift, truss/rafter, and connection requirements. It includes wind uplift load tables and roof-system connection details. | *No upgrade* | *No upgrade* | More mature roof component-and-cladding pressure framework and improved high-wind prescriptive features. |
| **Glazing Impact Resistance** | No special provision | *No upgrade* | Windows / glazed openings in WBDR required windborne-debris protection or building designed as partially enclosed. Texas's 2000 IRC revisions show ASTM E1996/E1886 large-missile testing and manufacturer installation requirements for protected openings. | Major clarification: protection applies to all exterior glazing, not just windows; ASTM E1996/E1886 large-missile testing remains central. | *No upgrade* |
| **Opening Protection** | Limited opening protection requirements | Stronger attention to hurricane envelope protection | Glazed/exterior openings protected in WBDR; wood structural panel exception allowed with fastening schedules and component-and-cladding load basis. | Major upgrade: new WBDR map, all exterior glazing clarified, ASTM E1996/E1886 wind zones, wood structural panel exception now tied to Wind Zones 1 and 2 rather than only the old 130 mph text. | *No upgrade* |

| Component | 1988 SBC | 1995 SBC | IRC 2000 | IRC 2012 | IRC 2021 |
|---|---|---|---|---|---|
| **Garage Door** | No special provision | *No upgrade* | Depending on jurisdiction/amendment, garage doors may be included in exterior opening protection. Texas's 2000 IRC revisions explicitly include garage doors within exterior openings in seaward areas. | Explicit garage-door glazed opening protection: garage-door glazed opening protection for windborne debris must meet an approved impact-resisting standard or ANSI/DASMA 115. | Major change: all garage doors must be tested to ASTM E330 or ANSI/DASMA 108 and labeled with positive/negative design pressure, model/series, installation reference, and test standard. |
| **Wind Design Parameters** | Wind speed, exposure, building height, roof geometry, and structural system. Less explicit component-level zoning for residential envelope performance than later IRC/ASCE approaches. | *No upgrade* | Wind speed, exposure, mean roof height, component-and-cladding loads, WBDR status, and limits of prescriptive design. | Revised WBDR mapping, ASTM E1996 wind zones, mean roof height limits for panel attachment tables, and clearer exterior-glazing protection requirements. | Ultimate/basic wind-speed maps, exposure category, mean roof height, effective wind area, component location, roof/wall zone, topography, and WBDR status. For garage doors, the IRC label is pressure-based rather than simply wind-speed-based. |
| **Exterior Wall Covering** | No special provision | Exterior wall covering and provisions for wall sheathing/ siding | Baseline IRC R703 material and installation provisions; wind resistance handled through fastening, approved materials, manufacturer instructions, and general wind design criteria. | More explicit reliance on product approvals/ evaluation reports for allowable design wind pressures; siding use limited to listed pressure ratings where applicable | R703 is more material-specific: vinyl siding, insulated vinyl siding, polypropylene siding, backed vinyl siding, and cladding over foam sheathing. Vinyl siding over foam plastic sheathing is specifically coordinated with design wind pressure requirements. |

## APPENDIX B: ACRONYMS

**AAL** – Average Annual Loss

**ACS** – American Community Survey

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

**BCEGS** – Building Code Effectiveness Grading Schedule

**BOCA** – Building Officials and Code Administrators

**CCI** – Construction Cost Index

**CPI** – Consumer Price Index

**EP (Curve)** – Exceedance Probability Curve

**IBHS** – Insurance Institute for Business & Home Safety

**ICBO** – International Conference of Building Officials

**ICC** – International Code Council

**I-codes** – Family of model building codes developed by the International Code Council

**IRC** – International Residential Code

**KCC** – Karen Clark & Company

**MDR** – Mean Damage Ratio

**PML** – Probable Maximum Loss

**PRC** – Property Replacement Cost

$\mathbf{R_{max}}$ – Radius of Maximum Winds

**SBC** – Standard Building Code

**SFH** – Single-Family Home

$\mathbf{V_{max}}$ – Maximum sustained wind speed at landfall

**WBDR** – Windborne Debris Region

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