# Final Research and Inventory Development Summary

*Resilient Housing Study*

**TEXAS GENERAL LAND OFFICE**

**9/11/2023 | FINAL**

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# INTRODUCTION

## OVERVIEW OF THE RESILIENT HOUSING STUDY

The Texas General Land Office – Community Development and Revitalization (GLO) is taking a leading approach to state management of Federal Emergency Management Agency (FEMA) dollars and the expansive, long-term vision for what U.S. Department of Housing and Urban Development (HUD) Community Development Block Grant – Disaster Recovery (CDBG-DR) funds can accomplish. By providing resilient homes to impacted families, resiliency is improved at both the household and community levels, while also protecting the public investment in homes constructed or repaired under CDBG-DR-funded housing programs.

The Resilient Housing Study expands the application of key construction processes and standards identified through this research to evaluate the full scope of housing programs that have been implemented since Hurricane Ike in 2008.

## OVERVIEW OF THE FINAL RESEARCH AND INVENTORY DEVELOPMENT SUMMARY

The Final Research and Inventory Development Summary is a compilation of key findings gathered throughout the analyses executed during Phases 1 and 2 of the Resilient Housing Study. Using these key findings, the Resilient Housing Study team developed a series of policy recommendations for increasing housing resilience across future CDBG-DR housing programs.

As a comprehensive summary of all analyses and information gathered throughout Phases 1 and 2 of this Study, the Final Research and Inventory Development Summary is separated into the following sections:

- **Methodology**: An overview of the process for developing the Final Research and Inventory Development Summary, explaining the purpose of Phases 1 and 2 of the Resilient Housing Study, as well as the interrelationships and purpose of each deliverable and analysis therein.
- **National Best Practices**: A summary of the methodology and key takeaways from the National Best Practices analysis.
- **Analysis of IBC/IRC Resiliency**: A summary of the methodology and key takeaways from the Analysis of IBC/IRC Resiliency.
- **Analysis of Economic Impact**: A summary of the methodology and key takeaways from the Analysis of Economic Impact.
- **Spatial Analysis**: A summary of the methodology and key takeaways from the Spatial Analysis.

- **Loss Avoidance Study**: A summary of the methodology and key takeaways from the Loss Avoidance Study.
- **Cost-Benefit Analysis**: A summary of the methodology and key takeaways from the Cost-Benefit Analysis.
- **Analysis of GLO Programs**: A summary of the methodology and key takeaways from the Analysis of GLO Programs.
- **Analysis of Peer State Programs**: A summary of the methodology and key takeaways from the Analysis of Peer State Programs.
- **Outreach**: A summary of the methodology and key takeaways from the Community Outreach Report.
- **Policy Recommendations and Next Steps**: A summary of all key results gathered across Study Phases 1 and 2, organized into a series of themes and policy recommendations, as well as next steps for the Resilient Housing Study.

# PURPOSE

The purpose of this document is to provide a comprehensive overview of the efforts and analyses conducted as part of the Resilient Housing Study across Phases 1 and 2. This is not a collection of all data gathered and all analytical work conducted, but a summary of key takeaways gathered throughout the process. These key takeaways are used to identify a series of policy recommendations for the GLO to utilize to increase the resilience of future post-disaster housing programs. For additional information regarding the full methodologies, data, and results across Study Phases 1 and 2, readers should consult the deliverables referenced and summarized in this document (see **Overview of Study Phases 1 and 2**).

# SCOPE

The information included in this report is pulled from a broad range of sources, including national and international reports, GLO project databases, CDBG-DR program beneficiary data, as well as outreach interview and survey responses. Although the Resilient Housing Study team strived to build this report from a comprehensive pool of data, the data used in this report is not all-inclusive. The priorities of the analysis (e.g., the prioritization of relevance to Texas post-Ike housing programs) and lack of available data resulted in a series of data gaps and exclusions. Refer to **Appendix E: Data Scope** for a full list of the data sets utilized in the Final Research and Inventory Development Summary, as well as key gaps and exclusions.

# METHODOLOGY SUMMARY

## OVERVIEW OF STUDY PHASES 1 AND 2

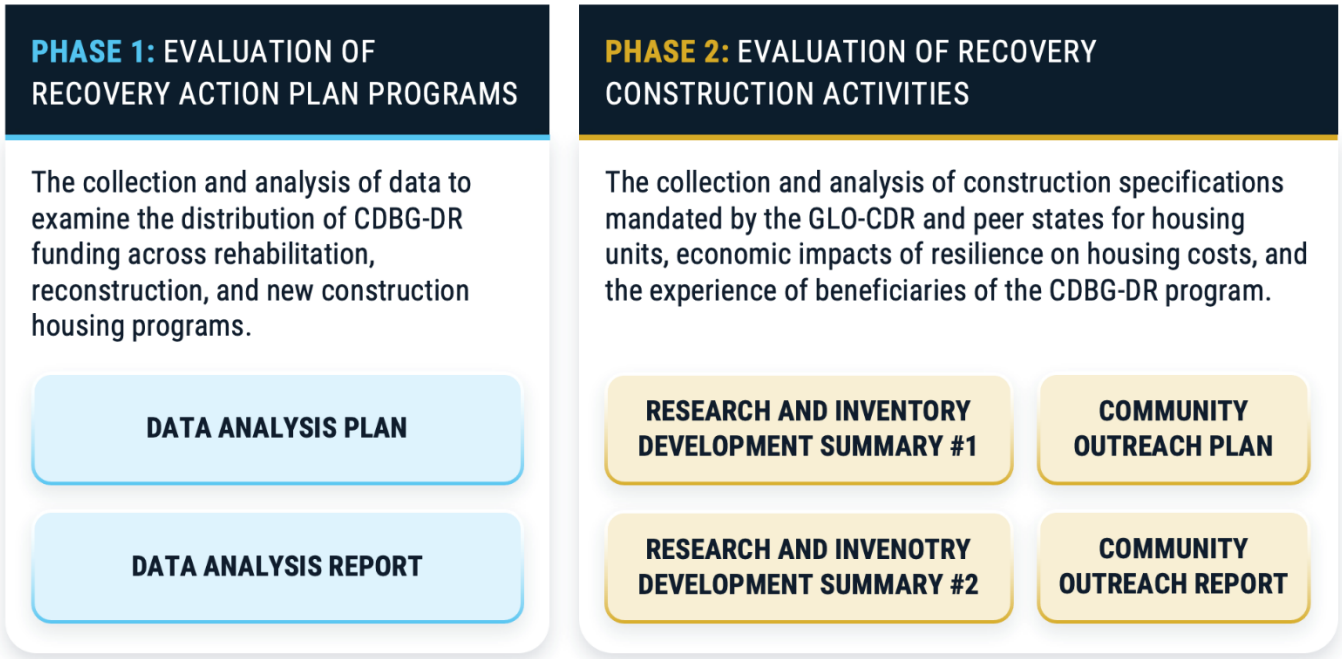



Figure 1: Overview of Study Phases 1 and 2

During Phase 1, the Resilient Housing Study team developed the *Data Analysis Plan*, a framework for collecting, cataloging, and cleaning data as part of all phases of the Resilient Housing Study. The Resilient Housing Study team further developed the *Data Analysis Report,* gathering and analyzing geospatial data of past GLO post-disaster housing programs, data on potential losses avoided across GLO disasters, and data on the cost-benefit of building approaches utilized across GLO post-disaster housing programs.

During Phase 2, the Resilient Housing Study team implemented the *Research and Inventory Development Summaries #1 and #2*, gathering and analyzing data on the construction specifications and policies and procedures utilized across GLO and peer state post-disaster housing programs, as well as literature reviews on resilience best practices and resilience and economic impact assessments of the International Building Code (IBC) and International Residential Code (IRC). During Phase 2, the Resilient Housing Study team also built out the *Community Outreach Plan*, a guide to executing outreach throughout the life of the Resilient Housing Study, and the *Community Outreach Report*, which captured and synthesized data collected through the Resilient

Housing Study's outreach efforts. Refer to **Table 1** for further information on the purpose of and analyses included in each of these plans and reports.

Table 1: Study Plans and Reports with Analyses Included

| | |
|---|---|
| **Data Analysis Plan**[1] | |
| The Data Analysis Plan defines the approach to data collection, cleaning, transformation, and analysis employed throughout the Resilient Housing Study lifecycle. This plan includes data sources that examine the distribution of CDBG-DR funding across the GLO housing program. | |
| **Data Analysis Report** | |
| The Data Analysis Report provides an assessment of how GLO programs have supported long-term community and housing resiliency. This assessment is completed by assessing resilience impacts through three complementary analyses of GLO CDBG-DR housing programs since Hurricane Ike in 2008. The results of the Data Analysis Report are presented as a series of key takeaways, goals, objectives, and recommendations to improve cost-effectiveness and resilience in GLO implementation of future allocations of CBDG-DR funds. | **Analysis Included:**<br>• Spatial Analysis<br>• Loss Avoidance Study<br>• Cost Benefit Analysis |
| **Research and Inventory Development Summaries #1** | |
| The Research and Inventory Development Summary #1 serves as an initial compilation and analysis of the standards and policies utilized by CDBG-DR-funded GLO housing programs, as well as national best practices for construction specifications and implementations. | **Analysis Included:**<br>• National Best Practices<br>• GLO Programs Practices |
| **Research and Inventory Development Summaries #2** | |
| The Research and Inventory Development Summaries #2 provide a comprehensive understanding of the construction standards and policies and procedures employed in the CDBG-DR-funded housing programs across Texas. This Summary includes a series of assessments that are meant to guide policymakers and post-disaster housing program leaders in prioritizing more resilient policies and construction standards across Texas. | **Analysis Included:**<br>• Analysis of IBC/IRC Resiliency<br>• Analysis of GLO Programs<br>• Analysis of Peer State Programs<br>• Analysis of Economic Impact |

[1] Note: As the Data Analysis Plan is not a report that includes resilience findings but a plan for how to collect and analyze data, it is not further analyzed in this report.

| Community Outreach Plan[2] |
|---|
| The Community Outreach Plan is a framework for the Resilient Housing Study team to use in implementing outreach efforts throughout the Resilient Housing Study. It includes engagement strategies, including interviews and surveys, that help the Resilient Housing Study team gather anecdotal and qualitative data to complement the quantitative data on CDBG-DR housing programs. |
| **Community Outreach Report** |
| The Community Outreach Report provides an analysis of the data collected from stakeholders during the outreach process. The results of the Community Outreach Report are presented as a series of key takeaways, goals, objectives, and recommendations to improve cost-effectiveness and resilience in GLO implementation of future allocations of CBDG-DR funds. |

# ANALYSES

As mentioned in the introduction, the Final Research and Inventory Development Summary is a summary of key findings identified through the 8 analyses developed throughout Phases 1 and 2 of the Resilient Housing Study. These analyses are as follows:

Table 2: Analyses, Purpose, and Deliverable Location

| National Best Practices | |
|---|---|
| A literature review of resources written by federal agencies, professional and non-governmental organizations, and academic institutions that capture industry best practices and innovative approaches to resilient construction. | |
| **Purpose** | This analysis provided the Resilient Housing Study team with a foundation of resilient housing construction best practices that helped guide the consequent analyses and contextualize findings and recommendations. |
| **Deliverable** | Research and Inventory Development Summary #1 |
| **Analysis of IBC/IRC Resiliency** | |
| A chronological study of the evolving resilience of International Building Code/International Residential Code (IBC/IRC) codes, conducted through comparative analysis and a quantitative scoring system. | |
| **Purpose** | The results of this analysis provided the Resilient Housing Study team a deeper understanding of the evolution of building codes and how these have impacted and can further impact post-disaster housing construction. |

[2] Note: As the Community Outreach Plan is not a report that includes resilience findings but a plan for how to conduct outreach, it is not further analyzed in this report.

| | |
|---|---|
| **Deliverable** | Research and Inventory Development Summary #2 |
| **Analysis of Economic Impact** | |
| An evaluation of the potential economic impacts and savings related to implementing updated building codes in Texas, conducted through a literature review of national and state-specific reports. | |
| **Purpose** | This analysis complements the Loss Avoidance Study efforts, providing the Resilient Housing Study team a comprehensive understanding of the current literature on the economic impacts of building codes in Texas. The results of this analysis helped guide policy recommendations related to I-Code updates. |
| **Deliverable** | Research and Inventory Development Summary #2 |
| **Spatial Analysis** | |
| A geospatial assessment of how GLO housing program resilience has evolved across disasters under different construction standards and codes. | |
| **Purpose** | This analysis helped the Resilient Housing Study team draw correlations regarding housing project data and geographical input, socioeconomic trends, and other contextual factors that can be gleaned through geospatial analysis. Aggregated beneficiary data from the Spatial Analysis was also utilized to calculate Cost-Benefit Analysis construction costs. |
| **Deliverable** | Data Analysis Report |
| **Loss Avoidance Study** | |
| A quantitative assessment of losses avoided in Texas due to adopting I-Codes, used to determine the cost savings of adopting resilient housing codes and standards. | |
| **Purpose** | Understanding losses avoided due to adopting I-Codes is critical to effectively implementing I-Codes across the State. As such, the results of this study helped guide recommendations related to I-Code updates. Furthermore, loss avoidance data from the Loss Avoidance Study was utilized to calculate Cost-Benefit Analysis benefits. |
| **Deliverable** | Data Analysis Report |
| **Cost-Benefit Analysis** | |
| An evaluation of the cost-effectiveness of building approaches utilized across GLO housing programs to support long-term community resiliency. | |
| **Purpose** | This analysis helped the Resilient Housing Study team understand the relationship between cost-effectiveness and resilience within GLO CDBG-DR housing programs. The results of this analysis helped guide policy recommendations to improve cost-effectiveness and resilience in future housing programs. |

| | |
|---|---|
| **Deliverable** | Data Analysis Report |
| **Analysis of GLO Programs** | |
| A resilience analysis of construction specifications and policies and procedures utilized in post-Ike CDBG-DR housing programs in the State of Texas, conducted through comparative analyses and a quantitative scoring system. | |
| **Purpose** | Through this analysis, the Resilient Housing Study team was able to better understand and compare the short-term and long-term impacts across the various program guidelines and implementation strategies of GLO's CDBG-DR housing programs. These comparisons helped guide policy recommendations related to construction specifications and policies and procedures. |
| **Deliverable** | Research and Inventory Development Summary #1 & #2 |
| **Analysis of Peer State Programs** | |
| A resilience analysis of construction specifications and policies and procedures utilized in post-Ike CDBG-DR housing programs in and across peer states, conducted through qualitative comparative analyses. | |
| **Purpose** | This analysis provided the Resilient Housing Study team an understanding of how comparable communities that have experienced similar disasters have designed and implemented their CDBG-DR housing programs. The Resilient Housing Study team used this comparative understanding to better understand the resilience impacts of Texas's CDBG-DR housing programs. |
| **Deliverable** | Research and Inventory Development Summary #2 |

Though these analyses were developed as part of different reports across Phases 1 and 2 of this Study, information gathered across each of these analyses has fed into or guided the development of multiple other analyses across the Resilient Housing Study. A comprehensive picture of the complex interrelationships across all these analyses cannot be fully captured in this report; however, the Resilient Housing Study team has aimed to represent some of the key ways these analyses are interconnected in **Figure 2**. This graphic breaks down the analyses by type (e.g., literature review, construction and policy, geospatial, and economic) and highlights the key element that an individual analysis imparts on another (e.g., standards, methodology, data, context).

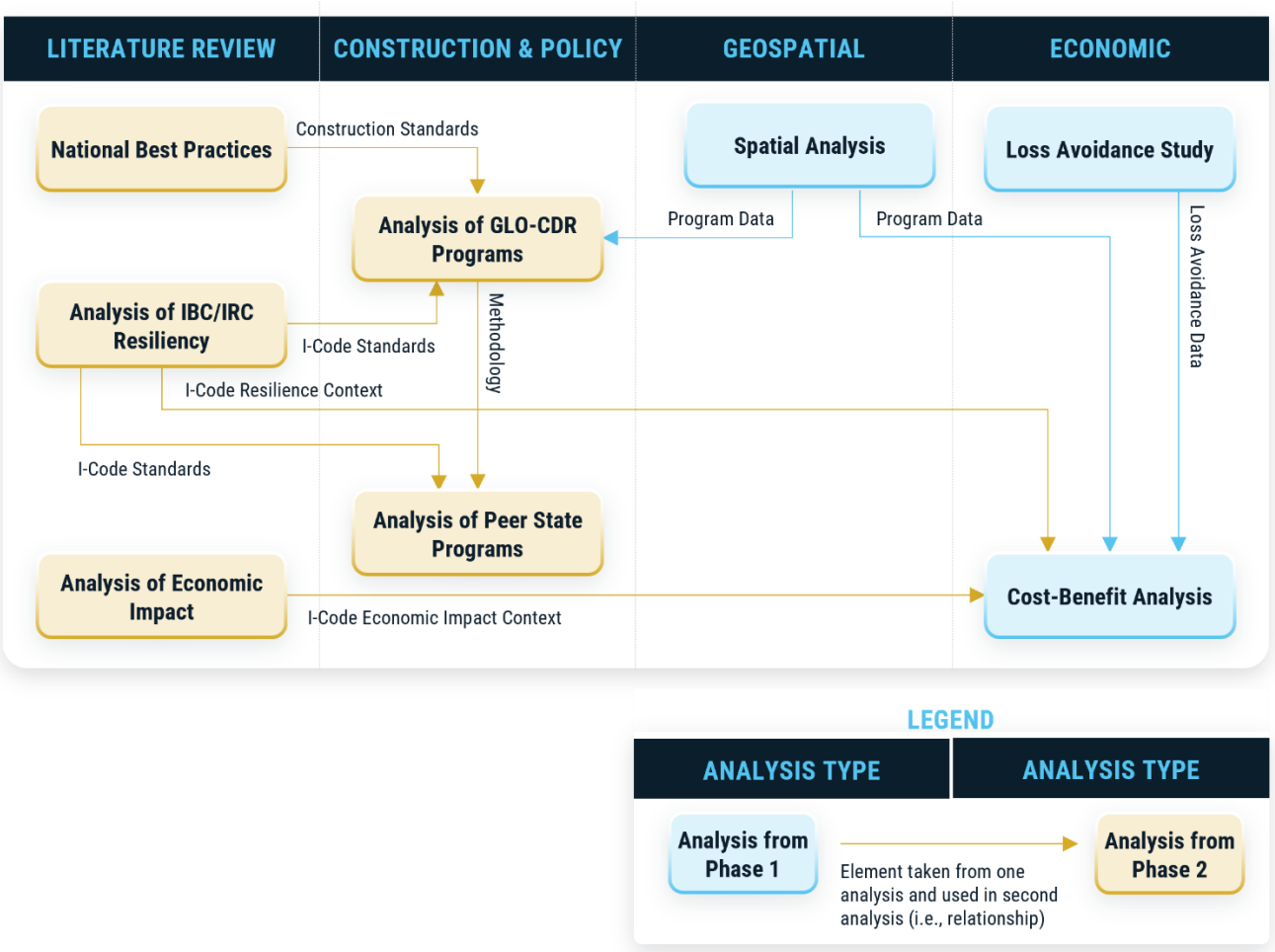



Figure 2: Study Analyses Key Interrelationships

# OUTREACH

In addition to data gathered through GLO data sets and open source research, the Resilient Housing Study team executed an outreach effort to complement quantitative data analyses with qualitative contextual information (for a full list of all data used across each analysis refer to **Appendix E: Data Scope**). Outreach data was used across all analyses, either to help guide the priorities of the analysis or as complementary anecdotal information. The results of the outreach efforts were also cataloged and analyzed in the *Community Outreach Report* (see **Outreach** for further information related to the outreach efforts conducted as part of Phases 1 and 2).

# POLICY RECOMMENDATIONS

Each of the analyses included in this report resulted in independent conclusions and data sets regarding the resilience of GLO housing programs, which can be found across the various sections titled “Key Takeaways” across this report. Pulling from these key takeaways, the Resilient Housing Study team identified key themes and associated policy recommendations that can help GLO increase resilience in future CDBG-DR housing programs. These observations are summarized in the **Policy Recommendations** section at the end of this report.

# NATIONAL BEST PRACTICES

## OVERVIEW

The National Best Practices analysis is a literature review of resources written by federal agencies, professional and non-governmental organizations, and academic institutions that capture industry best practices and innovative approaches to resilient construction. Information gathered through this analysis served to guide priorities and as contextual standards across the various analyses of the Resilient Housing Study.

For a detailed explanation of the purpose, process, and key takeaways, refer to the 'National Best Practices' section within the *Research and Development Summary #1*.

## METHODOLOGY

The Resilient Housing Study team evaluated and cataloged housing resilience best practices from multiple resources, including publications from the American Society of Civil Engineers (ASCE), International Residential Code/International Building Code (IRC/IBC), and Mitigation Assessment Team (MAT) reports. Information related to industry best practices and innovative approaches to resilient construction was extracted to create three distinct catalogs:

1) Standards and codes that promote resilience to hazard events;
2) IBC and IRC codes, which includes an analysis of their resilience impact across code publications, hazards, and Texas regions; and
3) Recommended construction approaches, which include an analysis of the resilience impact of housing components and practices against social and hazard resilience.

## KEY TAKEAWAYS

The National Best Practices analysis summarizes resources that capture industry best practices and innovative approaches to resilient construction. The following key takeaways were highlighted in this analysis:

### International Building Code and International Residential Code

Information collected from the data catalog of IBC and IRC within the National Best Practices analysis includes the following:

- **The Evolution of the IBC/IRC**: In addition to standard updates to codes conducted in each publication on a three-year basis, certain disasters have led to key changes to the codes.

- **Hazard-Specific Resilience**: Climatic and geographical design criteria, including updates to the flood, wind, and seismic design loads, are updated each three-year I-Code publication cycle, starting in 2006. Further hazard-specific resilience codes are referenced within the IBC and IRC, complementing the I-Codes specific for energy, fire, and extreme temperature hazard resilience.
- **Texas Regional Resilience**: Code implementation across Texas reveals the distinct issues relevant to each of Texas's regions in terms of implementation and compliance against region-specific hazards.
- **Implementing the IBC/IRC**: Implementation strengths and weaknesses of the IBC/IRC were categorized. Key strengths include the ability to (1) codify resilience research, (2) quantify costs and benefits, (3) generate rigorous standards, and (4) localize hazards. Weaknesses include (1) lack of support for new edition adoption, statewide adoption, and data for localizing model codes, (2) local capacity to enforce, as well as the impact of (3) Home Rule States, and (4) gaps in existing codes.

## Resilient Construction Specifications

Information collected from the data catalog of resilient construction specifications highlights the importance of measures related to structural stability. Factors that could improve resilience include elevation requirements in floodplains, adequate foundations to promote proper drainage, and specifications related to materials and techniques to be utilized in installation to improve damage resistance related to hazards such as wind, flood, and fire.

Additional measures to promote social resilience included specific measurements within room types (e.g., kitchen, bathroom, and hallway sizes to promote accessibility), and recommendations to carry out siting risk assessments to ensure integration of proper accessibility measures. The use of energy appliances to promote hazard energy resilience, the disuse of lead-based paint, the promotion of certain model types, the use of insurance policy, and the understanding of the useful life of units can also improve the resilience of a unit.

# ANALYSIS OF IBC/IRC RESILIENCY

## OVERVIEW

The Analysis of IBC/IRC Resiliency was used to understand how IBC/IRC, specifically those I-Codes available at the time of the GLO CDBG-DR programs, have evolved over time.

This analysis provides data that was utilized for the Analysis of GLO Programs and Analysis of Peer State Programs within the *Research and Inventory Development Summaries #1 and #2* and for the Cost-Benefit Analysis detailed in the *Data Analysis Report* as shown in **Figure 3**.

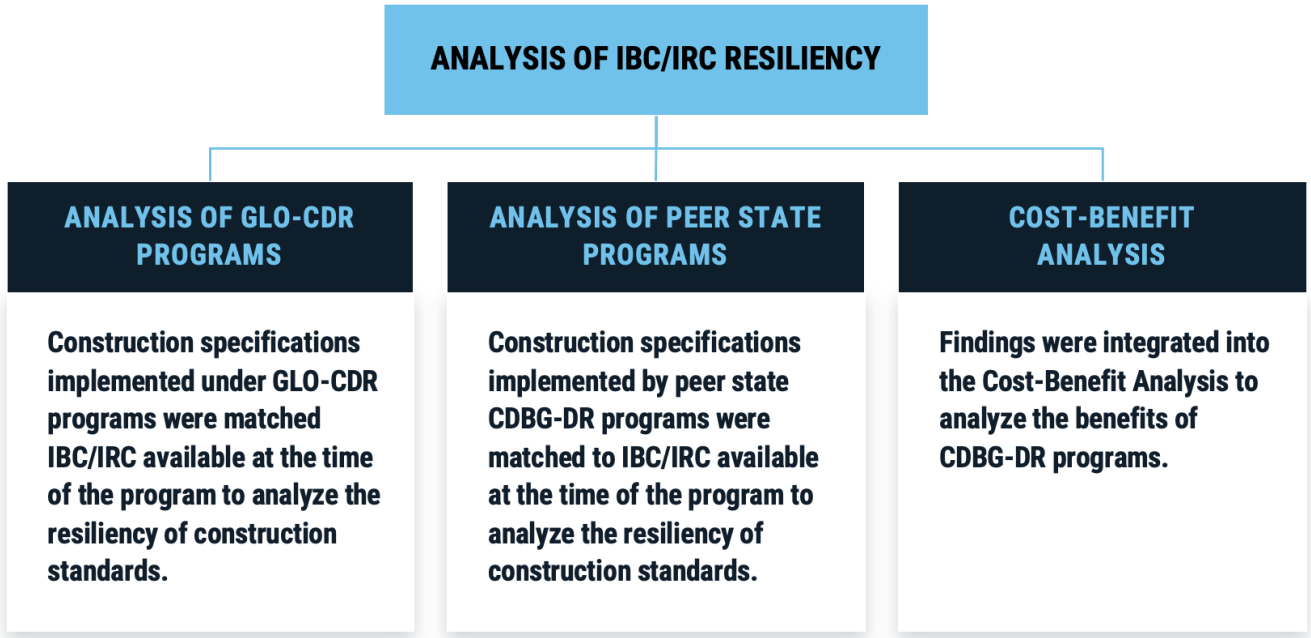



Figure 3: Use of Analysis of IBC/IRC Resiliency Findings for Other Analyses

For a detailed explanation of the purpose, process, including all equations utilized in this analysis, and key takeaways, refer to the 'Analysis of IBC/IRC Resilience' section within the *Research and Development Summary #2*.

## METHODOLOGY

The Resilient Housing Study team first reviewed the I-Codes to identify specific codes that were comparable to the key construction specifications detailed in each of the GLO CDBG-DR programs. IBC/IRC provisions from I-Code iterations 2006, 2009, 2012, 2015, and 2018 were matched to create 'groupings' of similar codes across

years, and each grouping was assigned a hazard resilience type. Four types of hazard resilience were utilized for this analysis (i.e., wind resilience, flood resilience, energy resilience, and fire resilience) then scored to reflect the change in code and its impact on improving hazard resilience. The scoring assignments and resilience factors were analyzed to understand the chronological changes in resiliency of the IBC/IRC iterations to create three areas of analysis (i.e., chronological changes in resilience factor, cumulative resilience factor, and significant code changes).

# KEY TAKEAWAYS

The Analysis of IBC/IRC Resiliency summarizes how IBC/IRC, specifically those I-Codes available at the time of the GLO CDBG-DR programs, have evolved. Through this analysis, the Resilient Housing Study team identified two key takeaways, included in the sections below.

## Improving Flood Resilience

**The flood resilience promoted by IBC/IRC evolved significantly between the 2006 – 2018 iterations compared to other hazard resilience types analyzed** (i.e., wind resilience, fire resilience, energy resilience). This is shown in **Figure 4** below, which provides a trend in resilience across I-Code years.

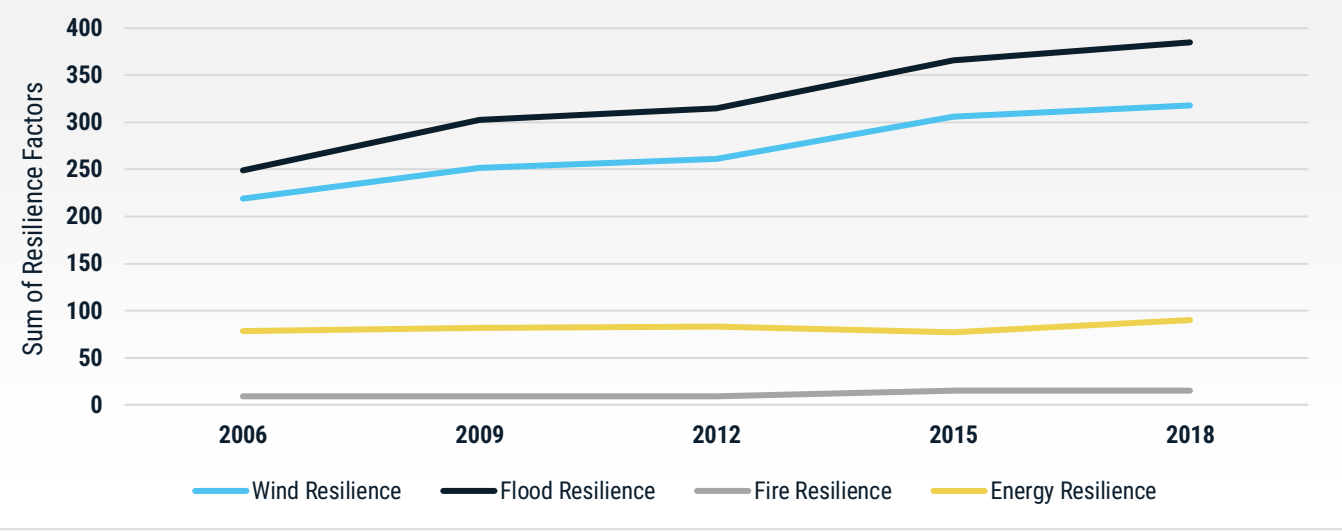



Figure 4: Resilience Factors Over Time

The significant changes identified correlate to more stringent requirements for buildings in flood hazard areas (e.g., 2012 IBC/IRC standards for spread footing foundation), elevation requirements (e.g., 2015 IBC/IRC requirement to measure BFE from the lowest floor of buildings and structures), and minimum mitigation expectations (e.g., 2015 IBC/IRC requirement for buildings located in more than one flood zone to adhere to the

standards of the more restrictive one). This indicates that **flood resilience of housing units increased as they were built to meet the requirements of newer IBC/IRC iterations.**

## Increased IBC/IRC Resilience

The 2018 IBC/IRC promoted the most hazard resiliency for buildings compared to the 2006 – 2015 iterations. The total resilience (inclusive of flood resilience, wind resilience, energy resilience, and fire resilience) of IBC/IRC provisions analyzed was most significant for the 2018 IBC/IRC (i.e., the cumulative resilience factor of the 2018 IBC/IRC was 808, which is 31% greater than the cumulative resilience factor of the 2006 IBC/IRC of 555). This indicates that **the overall resilience of housing units increased as they were built to provisions of newer IBC/IRC iterations**. This is highlighted in **Table 3** below.

Table 3: Distribution of Cumulative Resilience Factors by IBC/IRC Iteration

| IBC/IRC Iteration | Cumulative Resilience Factor | Ratio to Previous Year | % Change from Previous Year | % Change from Average |
|---|---|---|---|---|
| **2006** | 555 | N/A | N/A | -19.35% |
| **2009** | 646 | 1.16 | 16.40% | -6.13% |
| **2012** | 668 | 1.03 | 3.41% | -2.94% |
| **2015** | 764 | 1.14 | 14.37% | 11.01% |
| **2018** | 808 | 1.06 | 5.76% | 17.41% |

# ANALYSIS OF ECONOMIC IMPACT

## OVERVIEW

Utilizing more resilient building codes in housing construction can have a positive long-term economic impact on households and communities across Texas. The Analysis of Economic Impact identifies and evaluates the potential economic impacts and savings related to implementing updated building codes in Texas. To understand the full scope of potential economic impacts, the Resilient Housing Study team assessed relevant data and analyses from multiple studies, capturing a summary of impacts identified both at the national level and within the state of Texas.

For a detailed explanation of the purpose, methodology, including codes, equations and calculations, and key takeaways, refer to the 'Analysis of Economic Impact' section within the *Research and Development Summary #2*.

## METHODOLOGY

The Resilient Housing Study team first evaluated reports that provided a comprehensive view of the potential economic impact of updating codes. Both the *Natural Hazard Mitigation Saves 2019 Report*, published by the National Institute of Building Sciences, as well as the *Building Code Save: A Nationwide Study*, published in 2020, were analyzed to determine the depth of economic impact resulting from improved building codes.[3] [4] Both studies assessed the current economic impact of improved codes, as well as the projected impact of adhering to and building beyond these codes will have during future disasters.

Next, the Resilient Housing Study team then analyzed multiple National Association of Home Builders (NAHB) reports to determine the economic impact related to building-specific codes, as well as the cost for the household and/or developer in relation to updating codes in Texas. These reports track the increase in housing construction costs as a result of implementing the most recent iteration of I-Codes. The Resilient Housing Study team used these reports to calculate increases in housing construction costs, using case studies of a selection of reference houses that represented a standard unit within specific climate zones across the United States. The costs calculated were utilized as a baseline to capture code change costs to the household and/or developer, depending on the report. The Resilient Housing Study team translated the national estimated costs and additional costs provided across these reports into estimations focused regionally to Texas using adjustment factors

[3] NIBS, 2019. Natural Hazard Mitigation Saves. https://www.nibs.org/projects/natural-hazard-mitigation-saves-2019-report
[4] FEMA, 2020. Building Code Save: A Nationwide Study. https://www.fema.gov/emergency-managers/risk-management/building-science/building-codes-save-study#:~:text=FEMA's%20landmark%20study%2C%20%E2%80%9CBuilding%20Codes,each%20state%20and%20Washington%2C%20D.C

provided within the reports. Dallas was chosen to represent the Texas Region data for climate zone 3. Additional information about the methodologies for the NAHB analysis can be found on the NAHB website.

# KEY TAKEAWAYS

The Analysis of Economic Impact summarizes a comparative analysis of the potential economic impacts and savings related to implementing updated building codes in Texas. Key takeaways gathered from the Analysis of Economic Impact are summarized in the following sections.

## Cost of IBC/IRC Implementation

The cost ranges of adopting the latest IBC/IRC Codes were calculated by comparing the highest cost of code compliance with the lowest cost of code compliance by IBC/IRC for each hazard. **The cost ranges across all three I-Code iterations were determined to be of similar value.** Therefore, code implementation should comply with the latest set of codes to ensure cost-effectiveness. A table showcasing the cost of compliance by IBC/IRC is shown below:

Table 4: Total Cost of Code Compliance by IBC/IRC

| Hazard | 2012 IBC/IRC | | 2015 IBC/IRC | | 2021 IBC/IRC | |
|---|---|---|---|---|---|---|
| | High ($) | Low ($) | High ($) | Low ($) | High ($) | Low ($) |
| **Wind** | 1,932.84 | 582.12 | -1,466.64 | -3,182.76 | 4,881.24 | 4,153.80 |
| **Energy** | 6,935.88 | 4,868.64 | 7,048.44 | -1,173.48 | 1,305.36 | 453.60 |
| **Flood** | 2,236.92 | 894.60 | 12,374.04 | 10,635.24 | 3,515.40 | 1,226.40 |
| **Fire** | 4,297.44 | 29.40 | -218.40 | -197.40 | 0.00 | 0.00 |
| **General Resilience** | 1,606.08 | 204.96 | 243.60 | -2,858.52 | 6,850.20 | 2,990.40 |
| **TOTAL** | **17,009.16** | **6,579.72** | **17,981.04** | **3,223.08** | **16,552.20** | **8,824.20** |
| **AVERAGE** | **11,794.44** | | **10,602.06** | | **12,688.20** | |

## Implementation of Updated Codes in Texas

**There are many challenges in Texas related to implementing IBC/IRC codes, but there are practical measures that can be duplicated to reduce challenges related to implementation and enforcement.** These include:

- Streamlining resilience of local conditions by enforcing greater **uniformity** in land use controls and building codes statewide;

- Identifying **tradeoffs** of more resilient building standards (e.g., expanded timeframe for construction, upfront costs);
- Offering **resources** to offset related challenges; and
- Considering methods of **enforcement** of local code updates more effectively, using grant incentives, technical assistance, education, and outreach.

## Resources for I-Code Implementation

**Implementation of I-Codes can be costly, and these costs can inhibit private and public sector partners from including resilient construction practices.** Five case studies of programs implemented in other states using existing funding streams were assessed to highlight best practices or models for future GLO programs to offset costs related to I-Code implementation. Federal funding streams can also be leveraged by GLO to update housing codes and complete other activities to improve resilience in housing. **Leveraging existing funding to support efforts to implement IBC/IRC code changes in Texas can be an effective way to improve resilience in housing.** The Resilient Housing Study team identified the following potential funding streams as part of this analysis:

Table 5: Potential Federal Funding Streams

| **Building Resilient Infrastructure and Housing (BRIC)** | |
|---|---|
|  | BRIC funds are dispersed by FEMA and will support states, tribes, territories, and local communities as they engage in hazard mitigation projects, reducing risks faced from natural disasters and other hazards. The guiding principles of this program include supporting communities through capability and capacity building, encouraging and enabling innovation, promoting partnerships, enabling large projects, maintaining flexibility, and providing consistency. |
| **Hazard Mitigation Grant Program (HMGP)** | |
|  | HMGP funds are dispersed by FEMA to state, local, tribal, and territorial governments so they can develop Hazard Mitigation Plans (HMPs) and rebuild in a way that reduces, or mitigates future losses related to disasters within their communities. This grant funding is available when requested by an authorized representative, and available after a presidentially declared disaster. All applicants must be a participating jurisdiction in a FEMA-approved mitigation plan to be eligible for funding. |
| **CDBG-DR** | |
|  | CDBG-DR funding is dispersed through HUD and is intended to assist with rebuilding affected areas and provide seed money to begin the long-term recovery process and rebuilding after a disaster occurs. This grant assists cities, counties, and states recover from presidentially declared disasters, especially in low-income areas. CDBG-DR funds are subject to availability of supplemental appropriations and are based on unmet disaster recovery needs. |

## Community Development Block Grant Mitigation (CDBG-MIT)

CDBG-MIT is a congress-appropriated fund dispersed through HUD to assist eligible grantees in carrying out strategic and high-impact activities to mitigate disaster risks and future losses in areas impacted by recent disasters. Mitigation activities include those that increase resiliency to disasters, reduce or eliminate long-term risks related to loss of life or injury, damage to and/or loss of property, and reduction of suffering and hardship due to future disasters.

# SPATIAL ANALYSIS

## OVERVIEW

The Spatial Analysis is a geographic and socioeconomic impact assessment of CDBG-DR-funded programs and activities across the State of Texas. The goal of the Spatial Analysis is to draw correlations between CDBG-DR funds and the geospatial location of beneficiaries.

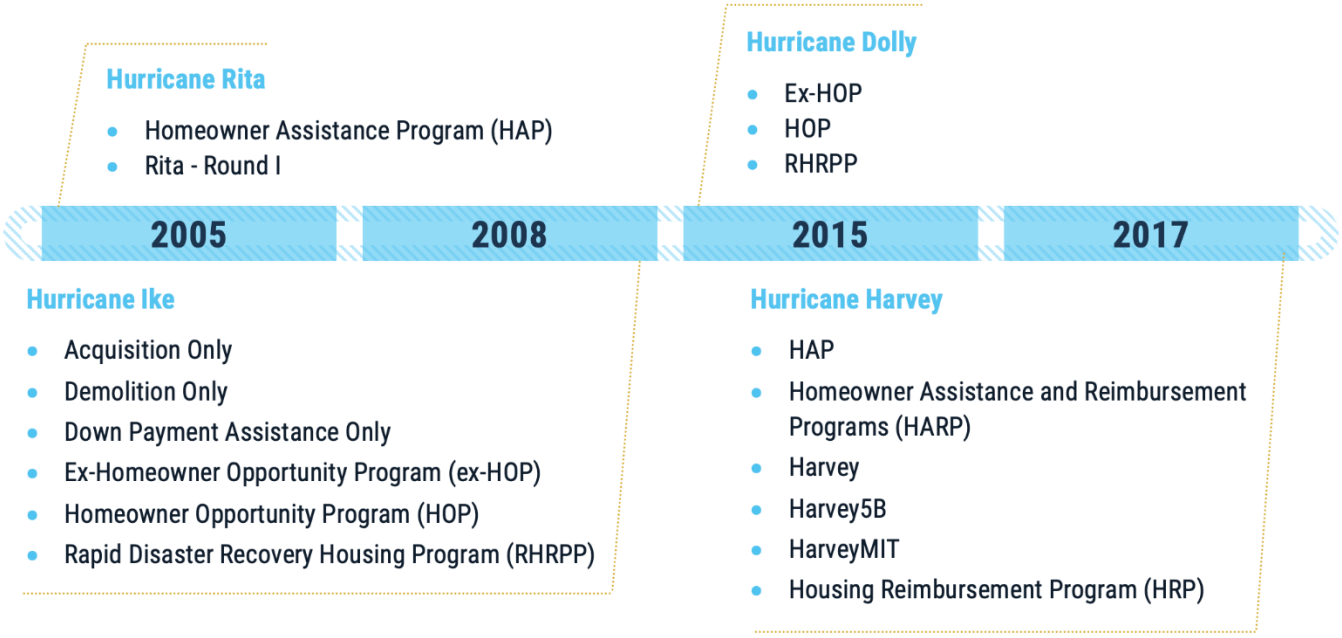



Figure 5: Timeline of Programs Assessed as Part of the Spatial Analysis

For a detailed explanation of the purpose, process, including a full list of variables included in the analysis, and key takeaways, refer to the 'Spatial Analysis' section within the *Data Analysis Report*.

## METHODOLOGY

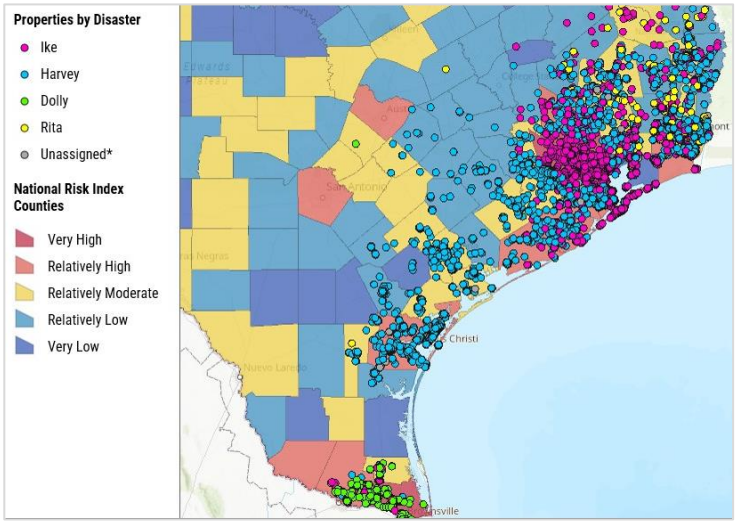
This analysis was conducted using Geographic Information Systems (GIS) capabilities to analyze a geospatially accurate dataset of CDBG-DR beneficiary information. CDBG-DR funds and the geospatial location of beneficiary housing units were assessed across a series of variables (e.g., disasters, counties, GLO programs, activities, physical characteristics, socioeconomic demographics, repetitive loss properties) for a comparative analysis.

# KEY TAKEAWAYS

The Spatial Analysis summarizes the assessment of CDBG-DR program impacts using the geolocation of CDBG-DR-funded projects across Texas. Key takeaways gathered from the Spatial Analysis are included in the sections below.

## Physical Characteristics

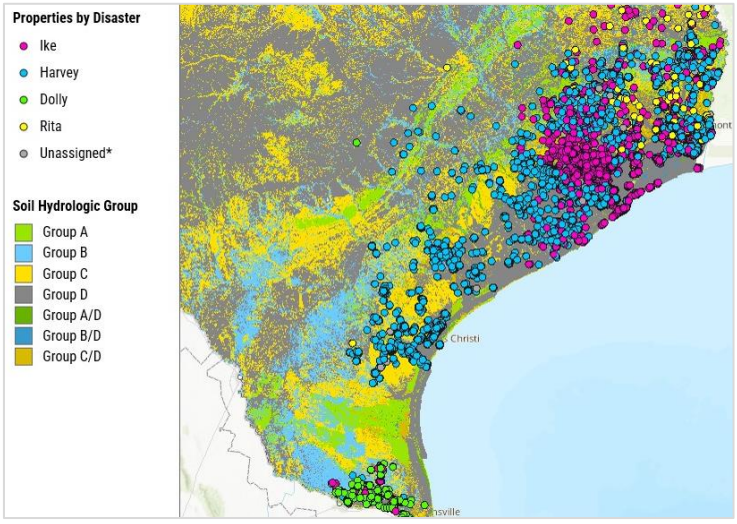
**Areas with a high flood risk and low elevation had the largest number of projects implemented, and most CDBG-DR funds were allocated to properties with soil type Group D, or soils with a very slow infiltration rate and high runoff potential.** This key takeaway indicates the possibility that housing built in areas with these physical characteristics is (1) the most likely to be impacted by disasters and (2) high-priority areas for CDBG-DR funds. This indication can be attributed to the impact of flood and wind events in areas with these types of physical characteristics.



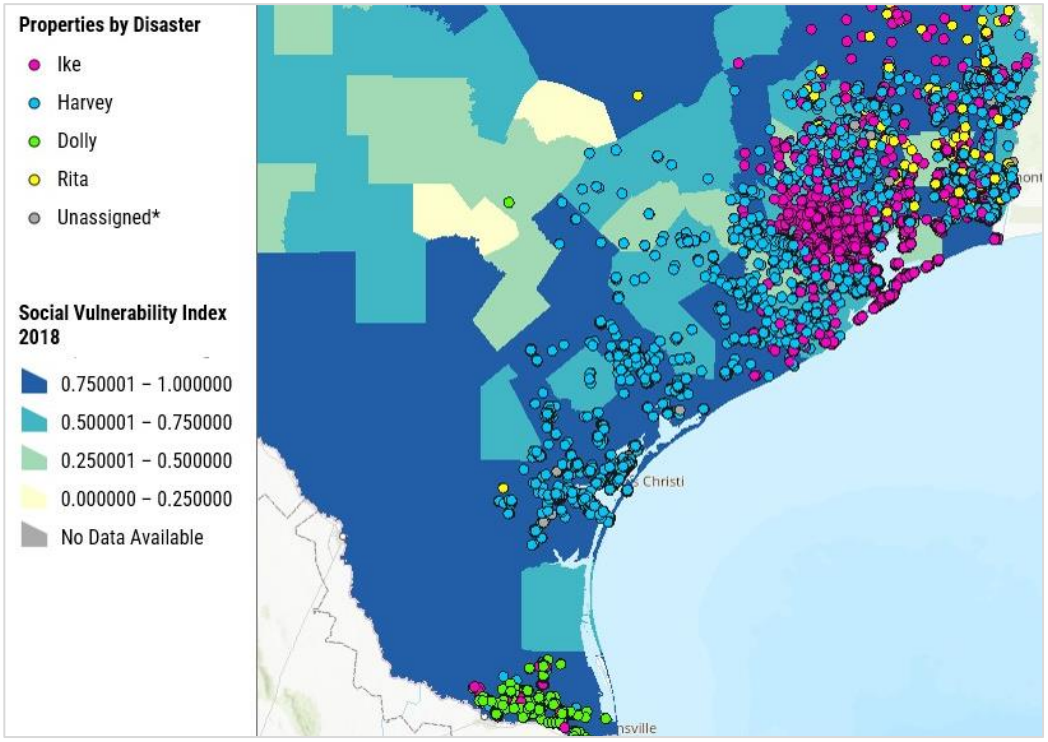

Map 1: CDBG-DR Funding and NFRI

## Socioeconomic Characteristics

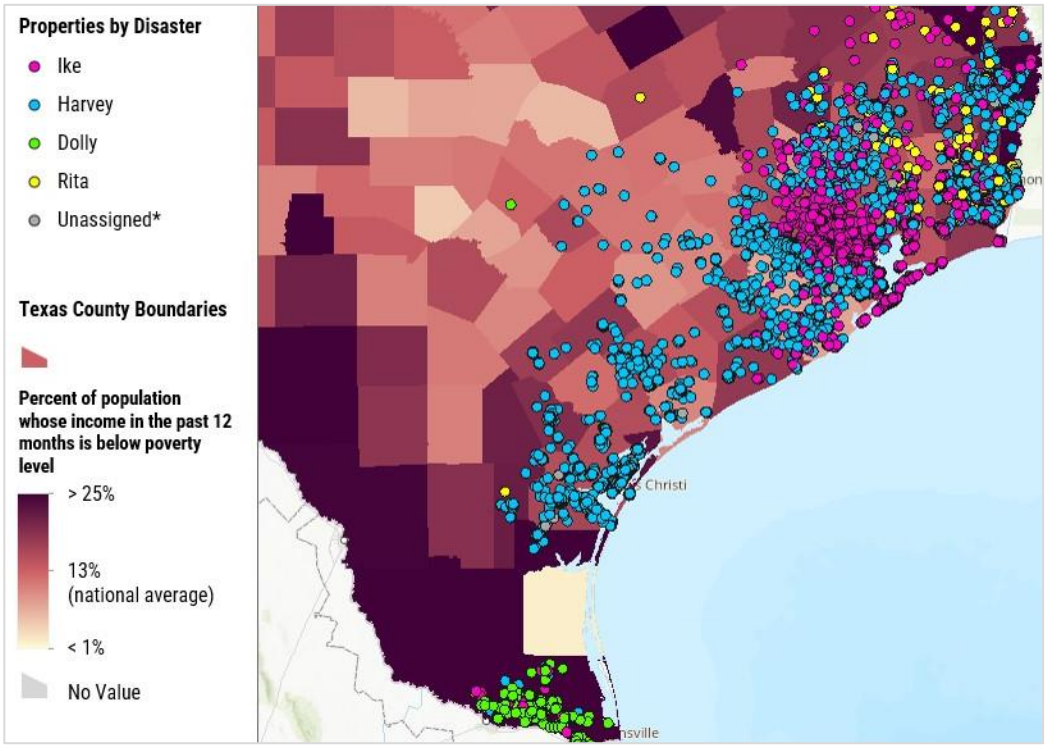
**Most CDBG-DR allocations were focused in areas with high poverty rates and socially vulnerable populations.** This is likely guided by the HUD regulation for allocation of CDBG-DR funds which prioritizes low-to-moderate income populations and most-impacted and distressed communities, which can be correlated to areas with high poverty rates and high social vulnerability. This takeaway could suggest the possibility that areas with social vulnerability and high poverty rates were impacted the most by the disasters, and therefore in the greatest need of assistance.




Map 2: CDBG-DR Funding and Soil Type



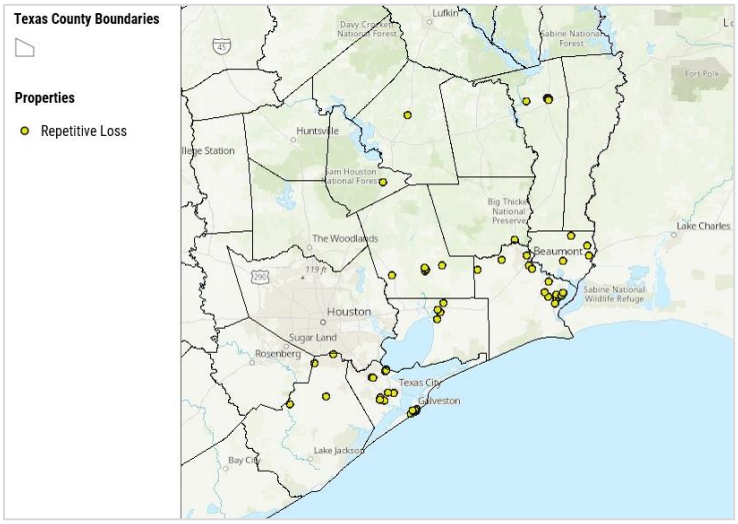

Map 3: CDBG-DR Funding and SVI




Map 4: CDBG-DR Funding and Poverty Rate

## Repetitive Loss Properties

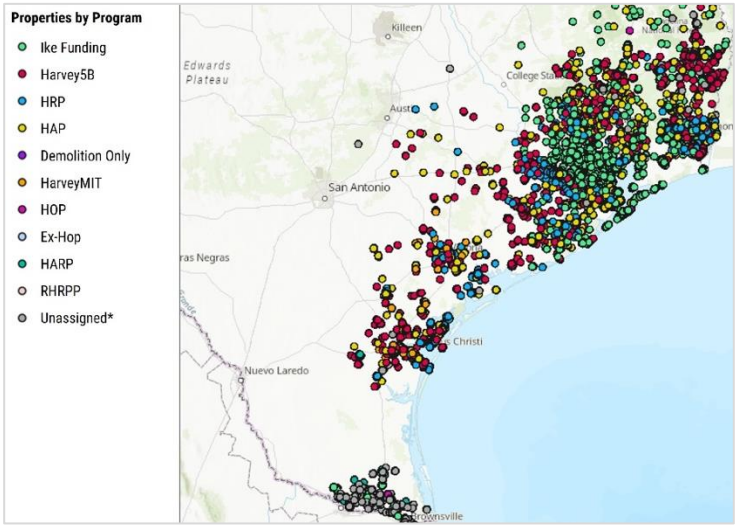
There are a total of 130 repetitive loss properties identified in this Study. **The data shows an increase in repetitive loss since Hurricane Ike in 2010**, which may be due to a variety of contextual factors. These include, but are not limited to, a lack of comprehensive data used in this Study, the limited scope of the Resilient Housing Study (i.e., the fact that the Resilient Housing Study only looks at programs post-Ike), as well as site-specific factors that would influence the repeated impact of disasters on certain units (e.g., repetitive loss properties identified and located in high flood risk areas). These repetitive loss properties were first damaged by Hurricane Ike in 2008 then again by Hurricane Harvey in 2018. **Repetitive loss properties were largely funded by the Hurricane Ike funding and the Homeownership Assistance Program (HAP), both of which implemented reconstruction and rehabilitation activities.** Considering all 26 associated factors, this takeaway highlights the importance of promoting more resilient long-term solutions for housing in high-risk areas (e.g., relocation and new construction options).




Map 5: Repetitive Loss Properties

## Geolocation of Implemented Projects

**The majority of CBDG-DR housing program allocations are clustered in Texas counties on the coast of the Gulf of Mexico, with Galveston County receiving the highest program allocations across all disasters.** This indicates that the coastline is a high-priority area for resilient housing investments, which could be attributed to the proximity of coastline counties to major wind and flood events. Climate change predictions from various agencies, including a recent report by the Virginia Institute for Marine

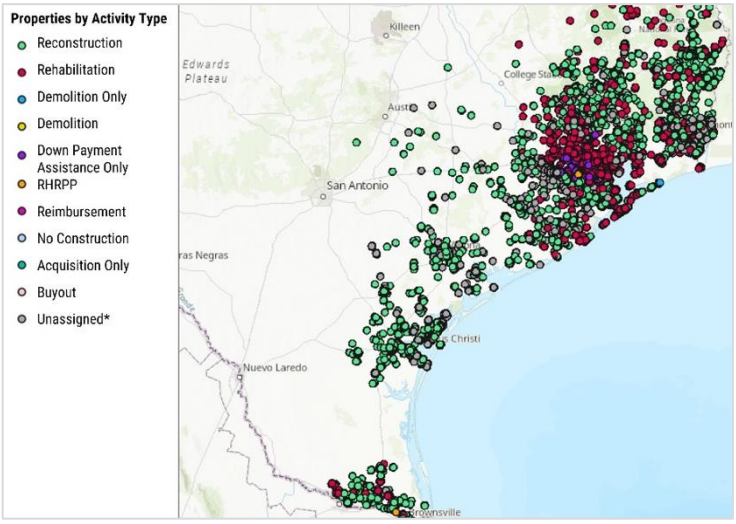



Map 6: CDBG-DR Allocations by Program

Science (VIMS)[5], indicate that the Gulf of Mexico coastline will see an increase in sea levels and more frequent and intense storms. This will increase the risk of flood and wind hazards and therefore may require an increase in resilient and cost-effective housing construction.

## Geolocation of Implemented Program Activities

Based on data analyzed, **reconstruction activities were the most heavily funded and most often performed of all the CDBG-DR activities funded by GLO**. **The largest number of reconstruction housing projects are implemented in Harris County.** These observations indicate the possibilities that decision-makers allocating CDBG-DR funds prioritized reconstruction. This may be due to (1) programmatic regulations in place favoring reconstruction, and (2) the scale of disaster impacts resulting in a greater need for reconstruction, as opposed to other CDBG-DR-funded activities.




Map 7: CDBG-DR Funding by Activity

[5] The 2018 report, "Anthropocene Sea Level Change: History of Recent Trends Observed in the U.S. East, Gulf, and West Coast Regions", can be downloaded from the VIMS website: https://www.vims.edu/research/products/slrc/index.php

# LOSS AVOIDANCE STUDY

## OVERVIEW

The Resilient Housing Study team conducted the Loss Avoidance Study to determine if adopting resilient housing codes and standards results in savings for CDBG-DR housing programs in the State of Texas. The results of the Loss Avoidance Study will inform recommendations to the GLO which can be implemented in future allocations of CDBG-DR funds.

For a detailed explanation of the purpose, process (including calculated losses, a list of variables and codes, and equations utilized in this analysis) and key takeaways, refer to the 'Loss Avoidance Study' section within the *Data Analysis Report*.

## METHODOLOGY

The Resilient Housing Study team calculated avoided losses using data provided in FEMA's *Building Codes Save* nationwide study. This report analyzed flood, hurricane wind, and seismic hazard construction specifications and quantified financial losses avoided by adopting hazard resistant building codes.

To apply this information to Texas programs, the Resilient Housing Study team calculated the Average Annual Avoided Losses (AAAL) by county, using avoided losses from adopting I-Codes as they relate to flood and wind resilience construction specifications for CDBG-DR funding housing programs. This was done by developing tiered adjustments of AAAL values to account for earlier I-Code edition years, then creating a comprehensive picture of the effectiveness of I-Code edition across GLO housing programs. The I-Codes were cataloged for each year (2006, 2009, 2012, and 2015)[6], then each code section was compared chronologically to identify key differences. These values were then used in a comparative analysis across multiple variables including counties, I-Code edition year, flood and wind codes, and disasters.

## KEY TAKEAWAYS

The Loss Avoidance Study summarizes the calculated losses avoided across Texas from implementing I-Codes. Key takeaways gathered from the Loss Avoidance Study are included in the sections below.

[6] The 2018 I-Codes were cataloged but excluded from this analysis as the State of Texas had not implemented these codes in any of their housing programs.

## I-Codes Adoption

**On average, each new edition of I-Codes saw a 186% increase in the value of avoided losses**, except for 2009 to 2012, which experienced a 143% increase in avoided losses. This increase in resilience is consistent with the expectation that implementation of updated I-Code editions improves resilience. This increase may also reflect an increase in the availability and affordability of cost-effective resilient construction standards, thus resulting in more avoided losses.

## Flood and Wind Hazards

**For most counties assessed in this Study, implementing resilient flood hazard codes would result in a higher value of avoided losses compared to implementing resilient wind hazard codes.** However, Aransas, Bee, Brooks, Calhoun, Galveston, Grimes, Kleberg, Lavaca, San Patricio, Starr, Willacy, and Wilson Counties would experience higher avoided losses from resilient wind codes across all I-Code edition years. These key takeaways highlight that more Texas counties could benefit more from increased flood resilience over wind resilience, which only more significantly benefits 15% of counties evaluated within this Study. These numbers could be impacted by the fact that most disasters analyzed within this Study are flood related. Therefore, CDBG-DR allocations largely went to flood retrofits, which are more extensive (i.e., encompass more aspects of a home) and more costly than resilient wind retrofits.

## Total Avoided Losses

**Counties with a higher population would have greater losses avoided (i.e., be less likely to incur significant damage due to a disaster) compared to counties with a lower population upon implementing more resilient codes.** This takeaway indicates a greater need for CDBG-DR allocations in higher density populations. It is worth noting, however, that these results may be due to different economic and resilient construction standard factors for rural versus urban communities (e.g., outreach representatives noted the higher cost of construction and lack of builders in rural areas) which can skew loss avoidance results.

# COST-BENEFIT ANALYSIS

## OVERVIEW

The Cost-Benefit Analysis was conducted using the results of the Spatial Analysis and the Loss Avoidance Study (see **Figure 6**) to evaluate the cost-effectiveness of CDBG-DR housing programs. This analysis assesses how different building approaches that support long-term community resiliency contribute to the cost-effectiveness of these programs.

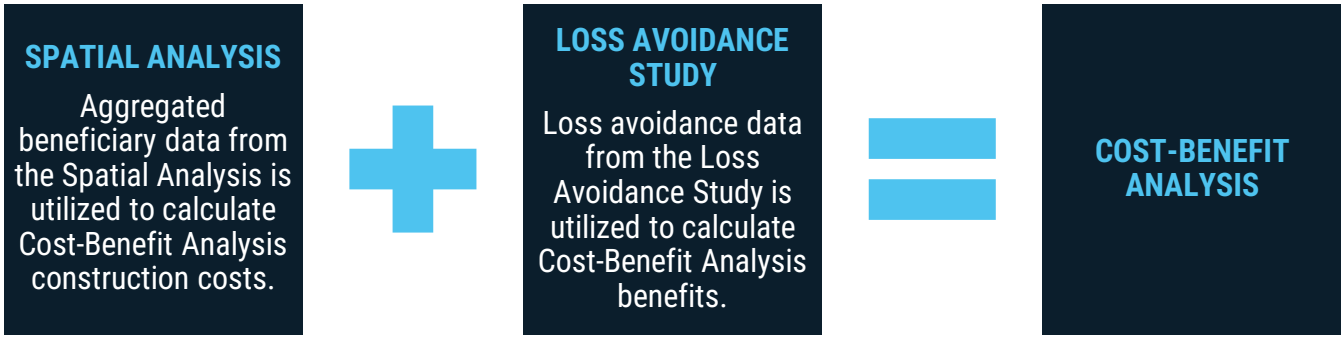



Figure 6: Relationship of Data Analysis Report Analyses

For a detailed explanation of the purpose, and process (including all equations utilized in this analysis), and key takeaways, refer to the 'Cost-Benefit Analysis' section within the *Data Analysis Report*.

## METHODOLOGY

The cost-effectiveness of CDBG-DR programs was determined through the development of a Benefit-Cost Ratio (BCR). To develop the BCR, the Resilient Housing Study team determined the benefits of adopting the I-Codes by weighing social benefits of resilient housing units, project useful life, and the FEMA Discount Rate for federally funded housing projects. The Resilient Housing Study team then determined the costs as total construction costs across all GLO programs for each county in Texas, considering Annual Operation & Maintenance (O&M) Cost[7] and the Present Value Coefficient (PVC).[8]

These results were then compared across Texas counties and I-Code edition years. For a project to be cost-effective and eligible for funding, most federal agencies, including FEMA, require the BCR to be 1.0 or greater, meaning the benefits of project outweigh its costs. When the Resilient Housing Study team calculated the BCR

[7] The O&M cost calculation is a component of FEMA's Benefit-Cost Analysis to fully estimate the project's overall investment costs in comparison to project benefits.
[8] The PVC is a product of the estimated useful life of the project and the discount rate used to account for the time value of money.

across the counties, some counties presented with a much higher or much lower BCR than other counties. This variance in BCR calculations can be attributed to counties whose calculated benefits outweigh calculated costs or vice versa.

# KEY TAKEAWAYS

The Cost-Benefit Analysis summarizes the calculated BCR of GLO CDBG-DR housing programs across Texas. Key takeaways gathered from the Cost-Benefit Analysis are included in the sections below.

## Benefit-Cost Ratio

The average BCR across all 58 counties included in the Cost-Benefit Analysis is 5.77. This indicates that (1) **the calculated social and economic benefits exceed CDBG-DR funding allocations**, and (2) based on the cost-effectiveness methodology outlined in this report, **the benefits of implementing resilient housing standards outweigh the differential cost of resilient housing funded through CDBG-DR housing program**. This result is consistent with previous studies on the cost-effectiveness of hazard mitigation and resilience projects.

It is important to note that applying the available FEMA methodology does not address the impacts related to specific hazard risks or consider all potential benefits comprehensively, and therefore provides a somewhat incomplete insight into overall impacts. Taking this into consideration, it is important to continue developing and employing a more detailed methodology for assessing the cost-effectiveness of hazard-resilient housing solutions.

## I-Codes Adoption

**The BCR calculated for the majority of counties has increased an average of 29% with each I-Code edition from 2006 to 2015.** Corresponding with findings from the Loss Avoidance Analysis, this result could be due to an increase in availability and affordability of more cost-effective resilient construction solutions. This increase highlights the importance of promoting higher resilience standards through the implementation and regulation of updated I-Code editions.

# ANALYSIS OF GLO PROGRAMS

## OVERVIEW

For the Analysis of GLO Programs, the Resilient Housing Study team analyzed the construction specifications and policies and procedures employed by GLO CDBG-DR programs since Hurricane Ike.


Figure 7: Timeline of Disasters Assessed in the Analysis of GLO Programs

For a detailed explanation of the purpose, process (including all equations and scoring metrics utilized in this analysis), and key takeaways, refer to the 'Analysis of GLO Programs' section within the *Research and Development Summary #2*.

## METHODOLOGY

To analyze GLO CDBG-DR programs, the Resilient Housing Study team designed a two-part process to allow for quantifiable analysis of both (1) construction specifications and (2) policies and procedures employed in these programs.

To evaluate construction specifications, programs were analyzed against national best practices (see **National Best Practices** for further information). First, all construction specifications were cataloged and categorized into 12 CSI designations. Next, specifications were compared qualitatively against the most recent IBC/IRC iteration available for that program (e.g., Hurricanes Ike and Dolly in 2008 were compared to the 2006 IBC/IRC) to identify whether these did not meet, met, or exceeded national standards. A scoring mechanism was developed (see **Table 6**) to translate this qualitative comparative analysis into quantifiable data on how construction specifications mandated by GLO did not meet, met, or exceeded national standards. This data assisted the Resilient Housing Study team in measuring resiliency of housing programs over time.

Table 6: Construction Specification Resilient Score System

| Specification Score | Analysis |
|---|---|
| 1 | GLO construction specifications do not meet IBC/IRC requirements. |

| Specification Score | Analysis |
|---|---|
| 2 | GLO construction specifications meet IBC/IRC requirements. |
| 3 | GLO construction specifications exceed IBC/IRC requirements. |

To evaluate policies and procedures, the Resilient Housing Study team designed a process to quantifiably analyze resilience. All post-Ike GLO policies and procedures (i.e., Hurricanes Ike and Dolly, 2015 and 2016 Disasters, Hurricane Harvey, and the 2018 and 2019 Disasters) were cataloged and then categorized into seven policy types, which fall within four themes (i.e., environmental, equity, financial management, and management). Next, the Resilient Housing Study team cataloged HUD Federal Register Notice (FRN) policies and procedures for the first FRN available for each of these disasters. Each GLO policy and procedure was compared qualitatively against its respective FRN policy and procedure to determine how the GLO policy or procedure met, did not meet, or exceeded HUD FRN standards. The Resilient Housing Study team developed a scoring mechanism (see **Table 7**) to translate this qualitative comparative analysis into a quantitative assessment of if GLO met, exceeded, or significantly exceeded federal standards.

Table 7: Construction Specification Resilient Score System

| Resilience Score | Analysis | Resilience Assessment |
|---|---|---|
| 1 | GLO policies and procedures meet HUD requirements. | Meets requirements |
| 2 | GLO policies and procedures exceed HUD requirements. | Exceeds requirements |
| 3 | GLO policies and procedures significantly exceed HUD requirements. | Significantly exceeds requirements |

# KEY TAKEAWAYS

The Analysis of GLO Programs summarizes key takeaways gathered related to construction specifications and policies and procedures employed by GLO CDBG-DR programs after Hurricane Ike. Key takeaways gathered from the Analysis of GLO Programs are included in the sections below.

## Construction Resilience and IBC/IRC Standards

**Most GLO construction specifications received a resilience score at or just below 2 (i.e., met requirements), as they generally met the most recently updated standards established by IBC/IRC codes.** The average resilience score remained relatively constant across all disasters, indicating that GLO was able to successfully meet IBC/IRC standards as they were updated. This can be seen in the table below. Most notably, GLO regularly

met or exceeded IBC/IRC standards for the following Construction Specifications Institute (CSI) divisions: 01 General Requirements[9], 03 Concrete[10], and 10 Specialties[11].

Table 8: Composite Resilience Benefit Score by CSI Designation

| CSI Designation | Hurricanes Ike and Dolly | 2011 Bastrop Wildfires | 2015 and 2016 Disasters | Hurricane Harvey |
|---|---|---|---|---|
| **01 General Requirements** | 2.20 | 2.00 | 2.00 | 2.00 |
| **03 Concrete** | 2.50 | 2.30 | 2.50 | 2.50 |
| **04 Masonry** | 1.50 | 2.00 | 1.00 | 1.00 |
| **06 Wood, Plastics, and Composites** | 1.63 | 2.00 | 2.00 | 1.94 |
| **07 Thermal and Moisture Protection** | 2.21 | 1.70 | 1.70 | 1.83 |
| **08 Openings** | 1.92 | 1.88 | 1.88 | 2.00 |
| **09 Finishes** | 2.00 | 2.00 | 2.00 | 1.80 |
| **10 Specialties** | 3.00 | 2.00 | 2.00 | 2.67 |
| **22 Plumbing** | 2.13 | 1.71 | 1.88 | 1.97 |
| **23 Heating Ventilating and Air Conditioning** | 1.67 | 1.67 | 1.67 | 1.67 |
| **26 Electrical** | 1.50 | 1.83 | 1.86 | 1.86 |
| **31 Earthwork** | 1.67 | 1.67 | 1.67 | 1.80 |
| **Total CSI Resilience Score** | **133** | **115.60** | **119** | **129.67** |
| **Composite Specification Resilience Factor** | **1.96** | **1.83** | **1.87** | **1.91** |

## Met and Sustained Program Requirements

**All GLO policies and procedures met standards established by HUD.** Hurricane Harvey had the highest number of policies reviewed and had the most policies with potential positive resilience impact. Resilient policies within Hurricane Harvey's programs were primarily focused on Green Building, Relocation Assistance, Financial

[9] The Construction Specifications Institute (CSI) utilizes a standard for organizing building specifications into a series of divisions. 01 General Requirements division includes general administrative project specifications.
[10] 03 Concrete division includes the maintenance, repair, and installation requirements for concrete.
[11] 10 Specialties division covers specialty products and materials that do not fall under other standard divisions.

Management, and Affirmative Further Fair Housing (AFFH). It is important to note that more robust and comprehensive policies and procedures provide more control during implementation but can also reduce flexibility within the program related to implementation and policy updates.

**GLO CDBG-DR policies and procedures do not change significantly, but generally further promote resilience over time and continue to meet standards set.** Specific policies related to Duplication of Benefits (DOB) and Financial Management have evolved through the 2018 and 2019 Disasters to meet changing HUD requirements. Policy changes are implemented generally as a result of significant changes in HUD requirements, likely to keep policies less restrictive during implementation. This analysis highlights priorities set by GLO related to resilience, specifically promoting the resilience of individuals and communities by providing timelier and more accessible interim and permanent housing solutions as well as promoting financial resilience of the program through appropriate funding procedures.

# ANALYSIS OF PEER STATE PROGRAMS

## OVERVIEW

To better understand the resilience impacts of Texas's CDBG-DR housing programs, it is essential to have an understanding of how comparable communities that have experienced similar disasters have designed and implemented their CDBG-DR housing programs. With this goal in mind, the Resilient Housing Study team developed the Analysis of Peer State Construction Specifications, which provides a comparative analysis of CDBG-DR housing programs implemented in peer states against relevant national standards (i.e., federal regulations and national building codes).

For a detailed explanation of the purpose, process (including all equations and scoring metrics utilized in this analysis), and key takeaways, refer to the 'Analysis of Peer State Programs' section within the *Research and Development Summary #2*.

## METHODOLOGY

The Resilient Housing Study team analyzed four peer state CDBG-DR housing programs using the same methodology applied to the Analysis of GLO Programs (see **Analysis of GLO Programs**) to provide a comparative analysis of CDBG-DR housing programs implemented in peer states against relevant national standards (i.e., federal regulations and national building codes). The state programs utilized in this study are shown in **Table 9** below, including Texas' Hurricane Harvey as a reference.

Table 9: Peer State CDBG-DR Programs Analyzed

| 2013 | 2016 | 2017 | 2018 |
|---|---|---|---|
|  |  |  |  |
| **New York**<br>Hurricane Sandy | **Louisiana**<br>2016 Flooding | **Texas (reference)**[12]<br>Hurricane Harvey | **Florida**<br>Hurricane Michael |

[12] Constructions specifications utilized in Texas during the time of Hurricane Harvey are illustrated alongside the peer states information, as reference.

Though the Analysis of Peer State Programs followed the methodology utilized in the Analysis of GLO Programs, it differs in three main ways, as outlined below:

Table 10: Analysis of GLO Programs

| Case Study Approach |
| --- |
| The Resilient Housing Study team assessed one CDBG-DR housing program for each peer state, as a sample to gather relevant insights that GLO can use to increase the resilience of their future housing programs. |
| **Qualitative Analysis** |
| This analysis involved a quantitative approach to determining resilience within each program (i.e., a resilience score was determined for each construction specification as they matched standards defined in the appropriate IBC/IRC iteration). |
| **Peer State and Texas Analysis** |
| The Resilient Housing Study team analyzed peer state documents primarily to identify guidance (i.e., policies and procedures, construction specifications) that could be applied to GLO policies and programs. |

# KEY TAKEAWAYS

The Analysis of Peer State Programs summarizes a comparative analysis of CDBG-DR housing programs implemented in peer states against relevant national standards. Key takeaways gathered from the Analysis of Peer State Programs are outlined in the following sections.

## Resilience Through Energy Efficient Construction

**All peer state construction specifications met or exceeded standards set by IBC/IRC at the time, however, implementation was varied across all states, highlighting differing resilience priorities.** Areas where increased resiliency led to higher resilience scores are areas where peer states and Texas enforced more rigorous standards, such as investing in high-quality construction materials (e.g., lumber, concrete) and following national best practices (e.g., California 93120). Additionally, Louisiana implemented highly resilient construction

specifications in areas where energy efficiency was prioritized (i.e., 07 Thermal and Moisture Protection[13], 08 Openings[14], and 22 Plumbing[15]).

## Met and Exceeded HUD Program Requirements

**All peer state programs met standards set by HUD across all policy types**[16]. Relocation assistance was the only policy that exceeded standards, underscoring the importance of accessible housing solutions. Housing program implementation varied greatly across all states, highlighting the need for more standard policy guidance federally. These results underscore priorities set by other states related to resilience.

## Promoting Community and Environmental Resilience

**Policies related to environmental resilience and relocation assistance had notable best practices.** Providing additional assistance to individuals during the relocation process can ensure populations have secure housing and promote individual resilience. Ensuring environmental sustainability by completing regular inspections and promoting green building standards can protect against future anticipated disasters. This indicates that there are various ways to promote resilience within programming, and best practices can be found within both Texas and peer state programs. Best practices from peer states can be considerations for future Texas programs.

[13] The Construction Specifications Institute (CSI) utilizes a standard for organizing building specifications into a series of divisions. 07 Thermal and Moisture Protection involves materials and practices used to seal and protect the outside of a building against moisture, thermal and air penetration.

[14] 08 Openings is a CSI division that includes the maintenance, repair, installation, or replacement requirements of products of construction that fill openings.

[15] 22 Plumbing is a CSI division that includes the maintenance, repair, installation, or replacement requirements of products of construction used for plumbing.

[16] All policy types include Environmental, Equity, Financial Management, and Management policies.

# OUTREACH

## OVERVIEW

The Resilient Housing Study team conducted a series of outreach efforts to complement, contextualize, and support the findings of analyses that were conducted during the Resilient Housing Study. Stakeholders that participated include recipients and implementers of GLO programs, experts in relevant construction codes and policies, federal representatives, and representatives of comparable peer state programs.

## METHODOLOGY

The Resilient Housing Study team followed the five-step outreach process to collect stakeholder input summarized below:

| | |
|---|---|
| **IDENTIFY KEY STAKEHOLDERS** | To capture information related to the impact of policies and construction standards on resilience, the Study team identified key stakeholder groups based on relevance and expertise as it relates to CDBG-DR programs, developing an Outreach Contact List. The complete list of stakeholder groups engaged can be found in Appendix C: Stakeholder Groups. |
| **CONDUCT OUTREACH** | The Study team-initiated contact with individuals on the Outreach Contact List, and updated the list throughout the outreach process, to reflect any changes to contact information or addition of experts that were recommended by engaged stakeholders. |
| **FACILITATE INTERVIEWS** | The interview process was structured to complement the expertise of the interviewee. These interviews were conducted using Google Meet or phone call depending on stakeholder preference. Some data requests were conducted via email. |
| **ENGAGE STAKEHOLDERS POST INTERVIEW** | If outstanding gaps in information were identified during the review and cataloging process of the interviews, the Study team reached out to stakeholders a second time to gather additional information and receive clarification. |
| **SHARE SURVEY** | Additionally, surveys were used to engage with past Texas CBDG-DR program recipients. Letters were sent to the addresses of 30 recipients of each program, for each disaster (as applicable). The letters contained a link that guided the recipients to an online survey. |

# KEY TAKEAWAYS

Key takeaways from the Community Outreach Report are summarized in the following table. These key takeaways are also used to support additional documents within the overall study, such as the *Data Analysis Plan* and the *Research and Inventory Development Summary #2*.

**Construction insights** gathered from stakeholders and CDBG-DR program beneficiaries inform the following key takeaways:

- There are multiple barriers to incentivization and adoption of model building codes, such as the lack of statewide codes and administrated resources needed to enforce building codes.
- A key barrier to providing more resilient homes is the increase in cost of construction and maintenance of resilient products and materials.
- Resilient construction specifications for wind and flood and new methods of construction including tilt-wall construction and 3D printed concrete have increased housing resilience.
- The process of vetting qualified contractors and inspecting their work should be prioritized to avoid fraud, waste, and abuse during program implementation.

**Equity insights** gathered from stakeholders and CDBG-DR program beneficiaries inform the following key takeaways:

- The cost of upgrading to resilient standards (e.g., the increase in the cost of maintenance and property taxes) should be considered over total ownership of the home, as they can be a financial burden on the homeowner.
- Educating homeowners on the benefits of resilient construction, home maintenance, and the process of reconstruction can support long term resilient housing.
- Extended displacement of homeowners impacts family dynamics from youth to the elderly and can lead to unintended consequences such as children having to change schools.
- Prioritizing the provision of ADA compliant homes that meet the specific needs of beneficiaries with disabilities can help in targeting these often-underserved populations.

**Management insights** gathered from stakeholders and CDBG-DR program beneficiaries inform the following key takeaways:

- Maintaining eligibility for additional federal funds is not always possible for homeowners experiencing financial hardship.
- Because of program criteria limits, available funds do not always allow reconstructing to long term resilient standards, which can avoid costly reconstruction in future disasters.

- The program application and verification process can be a complicated process for homeowners to follow and does not always allow for the consideration of all individual circumstances under the Duplication of Benefits (DOB) criteria.
- Better communication between homeowners, local governments, GLO, and local non-profits can help ensure programs are successfully implemented.
- Clear communication related to federal programs and options available to homeowners following a disaster should be done early and through a variety of mediums.

# POLICY RECOMMENDATIONS AND NEXT STEPS

## POLICY RECOMMENDATIONS

Key takeaways identified by the Resilient Housing Study team were categorized into five key themes to inform associated policy recommendations for GLO to consider for future CDBG-DR housing program allocations. An overview of themes and associated policy recommendations is provided in the table below.

Table 11: Key Themes and Policy Recommendations

| Theme and Theme Finding | Policy Recommendation |
|---|---|
| **Resilience Standards**<br>Lack of clear definition and development of resilience standards leads to a lack of understanding of program benefits and can lead to inconsistent implementation. | Expand and improve resilience standard |
| **Construction Specifications and Policies and Procedures**<br>Updating guidance to include the promotion of hazard resilient construction specifications and policies and procedures can provide targeted recommendations to create standardized and equitable resilient practices. | Update program guidance to further promote hazard and community resilience |
| **Data Collection**<br>Better data collection during program implementation could provide comprehensive information related to program implementation and allow for better program management. | Improve data collection |
| **Stakeholder Coordination**<br>Increasing CDBG-DR developer and other stakeholder coordination during program implementation can lead to consistent data collection, a standardized definition of resilience, and a shared understanding of resilient housing priorities in the State of Texas. | Increase developer and stakeholder coordination |
| **I-Code Adoption**<br>To increase cost-effectiveness and reduce repetitive losses, future CDBG-DR programs should prioritize the implementation of the latest edition of the I-Codes. | Implement the latest edition of the I-Codes |

Using identified themes and key takeaways gathered in the analyses conducted across the Resilient Housing Study and other gathered observations, the Resilient Housing Study team has generated the following policy recommendations for the GLO to consider for future CDBG-DR housing program allocations. A detailed explanation of each policy recommendation highlighted in the table above is provided here:

## Recommendation 1:
## Expand and Improve Resilience Standard

The Resilient Housing Study team determined that **employing more comprehensive and rigorous definitions of resilience and including them in dedicated program guidance can lead to higher resilience impacts for CDBG-DR housing programs**. Utilizing more descriptive construction specifications in guidance can allow for more standardized and precise housing construction and reconstruction activities under the CDBG-DR programs. This is especially critical for those Texas-specific specifications that exceed national standards, as omitting sufficient information regarding these can lead to inconsistent and even inadequate implementation. Continuing to maintain specific documentation regarding construction specifications for builders and homeowners can promote resiliency during program implementation.

However, there are some potential drawbacks to maintaining specific requirements. Construction standards with too much detail can become burdensome to implement and monitor, and the more standards that are maintained by the State, the more that must be updated over time. **Maintaining a balance of details will be critical to implementing effective construction specifications.** Additionally, some areas of construction specifications could include more specific details and requirements from GLO. For example, the New York program maintained specific documentation regarding the elevation of building elements. These details allowed for more standardized regulation of elevation methods across services provided under CDBG-DR, promoting equity across the program.

> Framing resilience standards to be specific to Texas can address outstanding needs at the community level. Guidance can exceed national baseline standards in a meaningful way, similar to the example provided for New York.

Through stakeholder outreach, several state and local representatives from across Texas identified that **a resilience definition should integrate an understanding of the resilience impact of housing maintenance and upgrading**. Some representatives highlighted that maintenance and upgrade costs over the long-term life of the project can be a hindrance to LMI households, thus limiting their ability to increase their own resilience and housing sustainability. These findings indicate that HUD's standard of resilience, which is the standard to which CDBG-DR post-disaster housing programs across the nation, including Texas, are held, is not strong enough to result in highly resilient housing programs in the State of Texas. **The GLO and other states should expand its**

**definition of resilience beyond minimum HUD standards to increase the overall resilience of housing programs and to reduce repetitive loss in future programs.** This can be done, for example, by incorporating FEMA resilience concepts.

## **Recommendation 2:** Update Program Guidance to Further Promote Hazard and Community Resilience

The Resilient Housing Study team identified that **key GLO program guidance for both construction specifications and policies and procedures can be (1) maintained as it promotes resilience or (2) further expanded to better promote hazard and community resilience of the program.** Current hazard resilience guidelines that should be maintained include the following:

- Methods related to elevations and building envelope requirements (i.e., 07 Thermal and Moisture protection requirement for water-resistive barriers) and other regulations mandated by the Green Building standards17;
- Improvements in roof construction for high wind resistance and construction of framing and foundations (e.g., 03 Concrete specifications for construction of interior beams and foundations); and
- Requirements that promote energy sustainability (e.g., 08 Openings requirements for ENERGY STAR-qualified window units) and resource conservation (e.g., 22 Plumbing requirements for shutoff valves).

These program guidelines may be further expanded to promote the resilience of housing units against future hazard events. The GLO may elect to:

- Adopt additional requirements regarding composite wood product compliance (e.g., Louisiana 06 Wood, Plastics, and Composites requirement regarding California 03120 specifications);
- Expand resource conservation measures (e.g., additional ENERGY STAR appliances); and
- Develop resiliency standards specific for repairs, to promote the sustainability of units that are repaired as well as those that are reconstructed.

Furthermore, **GLO promotes community resilience through the CDBG-DR programs by implementing accessible and equitable construction specifications and policies**. Current community resilience guidelines that should be maintained include the following:

- Construction standards that expand the living space available to beneficiaries (e.g., 01 General Requirements standards for ceiling height and dimensions of habitable rooms);

[17] The outreach conducted as part of the Resilient Housing Study notes that CDBG-DR requirements to elevate homes has been successful in protecting homes from repetitive flooding and future disaster events.

- Construction standards that consider adaptations to improve accessibility (e.g., 10 Specialties requirements for wheelchair clearances in bathroom dimensions);
- Policies that streamline efforts to support vulnerable populations in relocation (e.g., Relocation Assistance policies for programmatic updates to relocation efforts);
- Policies that increase the accessibility of the program (e.g., AFFH policies for public outreach efforts to target populations, DOB policies for excluding subsidized loans in DOB calculation to expand eligibility); and
- Policies that clarify eligibility requirements (e.g., Financial Management policies for updating affordability periods).

These program guidelines may be further expanded upon to promote the resilience of individuals and communities. The GLO may elect to:

- Expand particular policies, namely URA, DOB, and Financial Management. For example, GLO may elect to adopt the URA policy implemented by Florida, which offers onsite storage for homeowners who must remove personal belongings from their homes during construction, to assist individuals in their personal recovery process. The outreach conducted as part of the Resilient Housing Study notes that policies regarding DOB and Financial Management continue to be complex and not well understood by potential beneficiaries.
- Increase coordination between GLO, local governments, and communities to socialize requirements, provide accessible information, and effectively implement community resilience practices.

## Recommendation 3:
## Improve Data Collection

The Spatial Analysis, Loss Avoidance Study, and Cost-Benefit Analysis highlighted the importance of improved data collection techniques and standards as beneficial for (1) measuring resilience in past housing programs and (2) compiling lessons learned to increase the resilience and cost-effectiveness of future CDBG-DR allocations. As displayed in **Appendix E: Data Scope**, there are several data gaps within the overall data available on past GLO CDBG-DR housing programs, due to the recent digitalization of program data. As a result, a comprehensive analysis across all components of past programs was significantly reduced, highlighting the importance of ensuring future housing programs maintain high data management standards. **Improved data management policies and procedures can lead to improved controls during program implementation.** Moreover, as shown in the Resilient Housing Study, data collection provides the opportunity for future studies to analyze these programs more

> The GLO could expand upon HUD minimum data collection standards as a tool to effectively measure the overall resilience and cost-effectiveness of projects to improve impact of future CDBG-DR allocations.

comprehensively. This will ultimately result in the development of more accurate and effective approaches to improving overall program resilience in the future.

## Recommendation 4:
## Increase Developer and Stakeholder Coordination

**Increasing CDBG-DR developer and other stakeholder coordination during program implementation can lead to consistent data collection, a standardized definition of resilience, and a shared understanding of resilient housing priorities in the State of Texas.** GLO also should consider incentives that may be employed to guide integrating resilient construction practices into post-disaster housing repairs and rehabilitations funded through CDBG-DR. For example, the funding streams identified in the Analysis of Economic Impact (e.g., HMGP, BRIC) (see **Resources for I-Code Implementation** for full list) may be leveraged to educate private sector developers and homeowners about these practices. The GLO may also elect to follow guidance offered by TWIA for resilient construction methods. Increasing coordination and education among developers can improve the resiliency of future units constructed under the CDBG-DR program.

> During the stakeholder outreach process conducted as part of the Resilient Study, several state and local representatives pointed out that a lack of coordination across stakeholders involved in program implementation can be a barrier to increasing resilience and cost-effectiveness due to competing interests.

Additionally, representatives emphasized increasing coordination and shared understanding amongst all key construction stakeholders, such as real estate professionals, builders, engineers, and designers. Findings from the Spatial Analysis, Loss Avoidance Study, and Cost-Benefit Analysis point to a potential for improved stakeholder coordination that otherwise can result in inconsistent data collection processes and definitions of resilience. Increasing the coordination among stakeholders can lead to better data management, and therefore lead to increased resilient and cost-effective housing programs in Texas.

## Recommendation 5:
## Implement the Latest Edition of the I-Codes in CDBG-DR Programs

**To increase cost-effectiveness and reduce repetitive losses, future CDBG-DR programs should prioritize the implementation and advocacy of the latest edition of the I-Codes.** The findings in this Study highlight potential resilience benefits of CDBG-DR construction specification requirements with the most recent iteration of the IBC/IRC. In the latest CDBG-DR housing program, the State of Texas employed the 2012 I-Codes even though there were other, more recent editions (i.e., 2015, 2018, and 2021). Representatives in the stakeholder outreach

process stated that the standardization and clarity of codes and specifications would increase the affordability of homes, and therefore the resilience of homes.

Results from the Loss Avoidance Study and Cost-Benefit Analysis prove that **with each new edition of the I-Codes, the value of avoided losses increases, increasing the BCR over time**. Within the Analysis of IBC/IRC Resilience, findings depict how code provisions further promote hazard resilience with each update (i.e., the 2018 IBC/IRC provisions promote the most hazard resiliency for buildings compared to the 2006 – 2015 iterations). The most significant changes in hazard resiliency between iterations were the regulations related to flood resilience. Code provisions for buildings in flood hazard areas, elevation requirements, and minimum flood mitigation standards became more flood resilient over time. The *Natural Hazard Mitigation Saves* report notes that **spending $1 on construction to the 2018 IBC/IRC can save $11 in post-disaster repair and recovery costs**. Thus, Study findings show adopting newer IBC/IRC standards for GLO construction specifications will further promote hazard resilience. This recommendation may be expanded to include other I-Codes not included in this analysis, such as the International Fire Code, IECC, the International Plumbing Code, and/or other resilient codes (e.g., IBHS FORTIFIED).

While there are some drawbacks and local challenges to implementing updated codes, including upfront costs for retrofitting buildings to meet updated codes, limited county-level regulation, and variability at the local level, these cost increases are outweighed by the significant increase in resilience benefit for newer IBC/IRC iterations. Therefore, the Resilient Housing Study team recommends that code implementation comply with the latest iteration to ensure cost-effectiveness.

Adopting updated I-Codes can also benefit pre-disaster building construction in the State of Texas, although the outreach conducted as part of the Resilient Housing Study recognizes **there are programmatic challenges for implementing and regulating new I-Codes**. There can be higher labor costs associated with code implementation and high-quality resilient materials can be more costly to the developer and homeowners. Texas may elect to promote more resilient housing practices across the state by enforcing greater uniformity in land use controls and building codes across the State and offer direct resources to communities to offset the challenges of implementing and regulating code updates (e.g., financial incentives or subsidies for resilient construction methods).

# NEXT STEPS

The Final Research and Inventory Development Summary will feed into the following documents that will be developed as part of the Resilient Housing Study:

- Community Educational Outreach Plan;

- StoryMap;
- Comprehensive Resilient Housing Study Report; and
- Research and Inventory Development Summary #2.

## Community Educational Outreach Plan

Building upon the stakeholder outreach conducted in Phase 2, the Resilient Housing Study team will develop a Community Educational Outreach Plan to promote resilient home maintenance and mitigation strategies based on key takeaways from the Data Analysis Report, Research and Inventory Development Summary #1, and Research and Inventory Development Summary #2. The Community Educational Outreach Plan will include a vision, methodology, and materials to support outreach. This will include the development of a StoryMap (see below) to aid in this educational outreach strategy.

## StoryMap

The Resilient Housing Study team will build upon the results of the Data Analysis Report and the Research and Inventory Development Summaries to develop an ArcGIS StoryMap as part of Phase 3. The web-based tool will integrate maps, legends, text, and photos to provide information to stakeholders and the public on resilient housing initiatives in the State of Texas.

## Comprehensive Resilient Housing Study Report

Upon completion of the Final Research and Inventory Development Summary and Community Educational Outreach Plan, the Resilient Housing Study team will develop a comprehensive report that summarizes and aggregates the materials and deliverables completed over the course of the Resilient Housing Study. The Comprehensive Resilient Housing Study Report will consist of an executive summary, an overview of each deliverable, including key takeaways, recommendations, and strategies for operational implementation. The report will be presented to GLO staff upon completion.

# APPENDIX A: ACRONYMS

Table 12: Acronyms

| Acronym | Definition |
|---|---|
| **AAAL** | Average Annual Avoided Losses |
| **AAMA** | American Architectural Manufacturers Association |
| **AFFH** | Affirmatively Furthering Fair Housing |
| **ASEC** | American Society of Civil Engineers |
| **ASTM** | American Society for Testing and Materials |
| **AWC** | American Wood Council |
| **AWPA** | American Wood Protection Association |
| **BCEGS** | Building Code Effectiveness Grading Schedule |
| **BCR** | Benefit-Cost Ratio |
| **BFE** | Base Flood Elevation |
| **BRIC** | Building Resilient Infrastructure and Communities |
| **CAZ** | Combustion Appliance Zone |
| **CDBG-DR** | Community Development Block Grant - Disaster Recovery |
| **CDBG-MIT** | Community Development Block Grant - Mitigation |
| **CFR** | Code of Federal Regulations |
| **CSI** | Construction Specifications Institute |
| **CY** | Code Year |
| **DOB** | Duplication of Benefits |
| **DRRA** | Disaster Recovery Reform Act of 2018 |
| **DWV** | Drain-Waste-Vent |
| **EERO** | Emergency Escape and Rescue Opening |
| **ESS** | Energy Storage Systems |
| **FEMA** | Federal Emergency Management Agency |
| **FORTIFIED** | Fortified Construction Standards |
| **FRN** | Federal Register Notice |
| **FY** | Fiscal Year |

| Acronym | Definition |
|---|---|
| **GIS** | Geographic Information Systems |
| **GLO** | Texas General Land Office |
| **GOSR** | New York Governor's Office of Storm Recovery |
| **HAP** | Homeowner Assistance Program |
| **HARP** | Homeowner Assistance and Reimbursement Programs |
| **HRP** | Housing Reimbursement Program |
| **HOP** | Homeowner Opportunity Program |
| **HMGP** | Hazard Mitigation Grant Program |
| **HMP** | Hazard Mitigation Plan |
| **HUD** | U.S. Department of Housing and Urban Development |
| **IBC** | International Building Code |
| **IBHS** | Institute for Business and Home Safety |
| **I-Codes** | International Code Council Codes (including the International Building Codes and International Residential Codes) |
| **IECC** | International Energy Conservation Code |
| **IRC** | International Residential Code |
| **IWUIC** | International Wildland-Urban Interface Code |
| **LMI** | Low-to-Moderate Income |
| **MAT** | Mitigation Assessment Team |
| **MID** | Most Impacted and Distressed |
| **N/A** | Not Applicable |
| **NAHB** | National Association of Home Builders |
| **NDS** | National Design Specifications |
| **NEPA** | National Environmental Policy Act |
| **NGO** | Non-Governmental Organization |
| **O&M** | Operation & Maintenance |
| **PVC** | Present Value Coefficient |
| **RHRPP** | Rapid Disaster Recovery Housing Program |
| **SBA** | U.S. Small Business Administration |
| **SMACNA** | Sheet Metal and Air Conditioning National Association |

| Acronym | Definition |
|---|---|
| **STUDY** | Resilient Housing Study |
| **TDEM** | Texas Division of Emergency Management |
| **TWIA** | Texas Windstorm Insurance Association |
| **URA** | Uniform Relocation Assistance and Real Property Policies Act of 1970 |
| **VIMS** | Virginia Institute for Marine Sciences |

# APPENDIX B: DEFINITIONS

The following table defines key organizations, programs, and terms referenced in the Final Research and Inventory Development Summary.

Table 13: Definitions

| Term | Definition |
|---|---|
| **Average Annual Loss Avoided (AALA)** | Risk-based metric of the aggregated savings for a community derived from comparing reduced I-Code damage to pre-I-Code construction damage. |
| **Averaged Specification Score** | Score attributed to group of correlating construction specifications, per CDBG-DR program. (Note: This is a term developed by the Resilient Housing Study team for the exclusive use within this Study) |
| **Affirmatively Furthering Fair Housing (AFFH)** | Policies related to promoting fair housing equity across housing programs developed and implemented using CDBG-DR funds. These policies focus on promoting resilience in historically underrepresented communities to ensure they have accessible housing. |
| **Base Flood Elevation (BFE)** | Elevation of surface water resulting from a flood that has a 1% chance of equaling or exceeding that level in any given year. |
| **Building Resilient Infrastructure and Communities (BRIC)** | Funds dispersed by FEMA to support communities in identification of mitigation actions, implementation of projects that reduce risks posed by natural hazards, promotion of partnership to enable high-impact investments, support adoption and enforcement of codes and standards to facilitate community-wide risk reduction impacts and reduce past and future disaster losses. |
| **Code of Federal Regulations (CFR)** | Codification of general and permanent rules published in the Federal Register by the departments and agencies of the Federal Government, divided into 50 titles representing broad areas subject to Federal regulation. |
| **Community Development Block Grant – Disaster Recovery (CDBG-DR)** | Funds allocated by HUD that are utilized to help cities, counties, and state to recover from Presidentially declared disasters. |
| **Community Development Block Grant – Migration (CDBG-MIT)** | Funds allocated by HUD to assist eligible grantees in carrying out strategic and high impact activities to mitigate disaster risks and future losses in areas impacted by recent disasters. |
| **Composite Resilience Benefit Factor** | Average of all policy resilience benefit scores attributed to one CDBG-DR program. (Note: This is a term developed by the Resilient Housing Study team for the exclusive use within this Study) |

| Term | Definition |
|---|---|
| **Composite Specification Resilience Factor** | Average of all averaged specification scores, per CDBG-DR program. (Note: This is a term developed by the Resilient Housing Study team for the exclusive use within this Study) |
| **Construction Specifications Institute (CSI)** | National not-for-profit association focused on improving the communication of construction information throughout continuous development and transformation of standards and formats, education, and certification of professionals to improve project delivery processes. |
| **CSI Resilience Score** | Score attributed to group of correlating construction specifications, per CSI designation. (Note: This is a term developed by the Resilient Housing Study team for the exclusive use within this Study) |
| **Duplication of Benefits (DOB)** | Policies for the regulation of CDBG-DR fund disbursement when the total assistance received across multiple funds is more than the total need for assistance. These policies have impact on community and program resilience, as well-designed DOB policies can help promote effective distribution of funds and sustainable financial management for long-term sustainability. |
| **Federal Emergency Management Agency (FEMA)** | Federal agency who primary purpose is to coordinate the response to a disaster that has occurred in the United States and that overwhelms the resources of local and state authorities. |
| **Federal Register Notice (FRN)** | Notice of proposed rules and regulations published within the official journal of the federal government, including regulations for CDBG-DR. |
| **Texas General Land Office (GLO)** | Lead state agency for managing the state's Community Development Block Grant - Disaster Recovery grants through the U.S. Department of Housing and Urban Development. |
| **Hazard Mitigation Grant Program (HMGP)** | Funds dispersed by FEMA to state, local, tribal, and territorial governments so they can develop HMPs and rebuild in a way that reduces, or mitigates future losses related to disasters within their communities |
| **U.S. Department of Housing and Urban Development (HUD)** | US federal agency responsible for national policy and programs that addresses national housing needs, improves and develops communities, and enforces fair housing laws. |
| **International Building Code (IBC)** | Model building code developed by the IECC to be applied to most types of new buildings and promote efficiency and protect health and safety. |
| **International Code Council Codes (I-Codes)** | Reference to the group of fifteen groups of modern building safety codes developed by the International Code Council to help ensure safe, sustainable, affordable, and resilient structures. |

| Term | Definition |
|---|---|
| **International Energy Conservation Code (IECC)** | Model building code for minimum efficiency standards related to a structure's walls, floors, ceilings, lighting, windows, doors, duct leakage, and air leakage in new construction. |
| **International Residential Code (IRC)** | Model building code for all building, plumbing, mechanical, fuel gas, and electrical work related to one- and two-family residences and townhouses up to three stories. |
| **Low-to-Moderate Income (LMI)** | Individual defined as a "person in a family or an individual with an annual income equal to or less than HUD Section 8 Low Income Limit" by Section 102(a)(20) of the Housing and Community Development Act of 1974. |
| **Most Impacted and Distressed (MID)** | Areas that have Individual Assistance or Individuals and Household Program designation as well as have concentrated damage as determined by the amount of unmet housing needs. |
| **Policy Resilience Benefit Score** | Average of all resilience scores attributed to one policy type, per CDBG-DR program. (Note: This is a term developed by the Resilient Housing Study team for the exclusive use within this Study) |
| **Resilient Housing Study** | Multi-faceted community and housing resilience assessment of CDBG-DR housing programs implemented in the State of Texas since Hurricane Ike in 2008. |
| **Resilience Score** | Score attributed to one policy and procedure provision based as compared to one HUD FRN regulation. (Note: This is a term developed by the Resilient Housing Study team for the exclusive use within this Study) |
| **Specification Score** | Score attributed to one construction specification, based on comparison to one IBC/IRC provision. (Note: This is a term developed by the Resilient Housing Study team for the exclusive use within this Study) |
| **Theme Resilience Benefit Score** | Average of all resilience scores attributed to one theme, per CDBG-DR program. (Note: This is a term developed by the Resilient Housing Study team for the exclusive use within this Study) |
| **Uniform Relocation Assistance and Real Property Policies Act of 1970 (URA)** | Act that establishes minimum standards for federally funded projects and programs that require procurement, rehabilitation or demolition of real estate or displace individuals from homes or businesses. |

# APPENDIX C: REFERENCES

Table 14: External Resources

| Document Title | Year | Author / Institution |
|---|---|---|
| **National Best Practices** | | |
| Affordable Housing Construction Program Guide: Homeownership Production Program | 2022 | State of Nebraska CDBG-DR Program |
| Building a More Resilient Housing System | 2018 | Rice University |
| Building Codes Save: A Nationwide Study - Losses Avoided as a Result of Adopting Hazard-Resistant Building Codes | 2020 | FEMA |
| Building Codes Strategy | 2022 | FEMA |
| Building Equity into Federal Investments for Housing Resilience | 2021 | Harvard University |
| Final Report on the Back Home Rapid Housing Recovery Pilot Program | N/A | Houston-Galveston Area Council |
| Housing Policies that Save (and Improve) Lives, Protect Assets and Shield Economies | 2018 | World Bank |
| Housing Resiliency Program Guide | 2022 | State of Nebraska CDBG-DR Program |
| Mitigation Assessment Team Report - Hurricane Harvey in Texas: Building Performance Observations, Recommendations, and Technical Guidance | 2019 | FEMA |
| Mitigation Assessment Team Report - Hurricane Ike in Texas and Louisiana: Building Performance Observations, Recommendations, and Technical Guidance | 2009 | FEMA |
| Rapid Disaster Recovery Housing Program | 2015 | Texas A&M University |
| Resilient Retrofits: Climate Upgrades for Existing Buildings | 2022 | Urban Land Institute |
| Rapid Disaster Recovery Housing Program - Technical Guide Appendix: Core | 2015 | Texas A&M University |
| **Analysis of GLO Programs** | | |
| City of Galveston Round 2 Single Family Guidebook | 2013 | Hurricanes Ike and Dolly |
| CDBG-DR Program Hurricanes Ike and Dolly Round 2 | N/A | Hurricanes Ike and Dolly |

| Document Title | Year | Author / Institution |
|---|---|---|
| Disaster Recovery Program: Project Implementation Manual | 2009 | Hurricanes Ike and Dolly |
| Galveston County – Hurricane Ike Disaster Recovery Round 2 CDBG Housing Program Guidelines | 2013 | Hurricanes Ike and Dolly |
| GLO Contract No. 12-505-000-6718 CDBG-DR Program Rental Housing Projects Round 2 Subrecipient Grant Agreement | 2019 | Hurricanes Ike and Dolly |
| Hurricanes Ike and Dolly – Round 2 Housing Guidelines | 2014 | Hurricanes Ike and Dolly |
| Ike and Dolly Round 2 Minimum Design Standards | 2014 | Hurricanes Ike and Dolly |
| New Standards Summary | 2015 | Hurricanes Ike and Dolly |
| Round 2 Housing Construction Specifications (Single Family) | N/A | Hurricanes Ike and Dolly |
| Round 2 Housing Design Standards (Single Family) | 2016 | Hurricanes Ike and Dolly |
| Lower Rio Grande Valley Development Council Disaster Recovery Housing Program Round 2 Single Family Guidebook | 2012 | Hurricane Dolly |
| Single Family and Multifamily Rental Program Guidebook | 2012 | Hurricane Dolly |
| Single Family Visitability Standards Checklist | 2015 | Hurricanes Ike and Dolly |
| Bastrop Disaster Recovery Program: Home Builder Scope of Work | N/A | Bastrop 2011 Wildfires |
| GLO Contract No. 18-417-000-B126 CDBG-DR Program Housing Projects: Non-Research & Development 2015 Flood Allocation | 2017 | 2015 Floods |
| GLO Contract NO. 19-076-049-B702 CDBG-DR Program Housing Projects: Non-Research & Development 2016 Flood Allocation | 2017 | 2016 Floods |
| Affordable Rental Program Standard Operating Procedures Version 7 | 2021 | Hurricane Harvey |
| GLO Contract NO. 19-097-028-B646 Multi-Family Residential Construction Repair Services Grant Agreement Disaster Recovery Program Housing Projects: Hurricane Harvey Funding | 2020 | Hurricane Harvey |
| Hurricane Harvey: Disaster Recovery: Housing Guidelines | 2021 | Hurricane Harvey |

# APPENDIX E: DATA SCOPE

Table 15: Data Scope

| Data Being Utilized | Current Data Gaps | Exclusions |
|---|---|---|
| **National Best Practices** | | |
| ***Subcomponent**: National Best Practices* | | |
| ***Description:*** | | |
| • Affordable Housing Construction Program Guide: Homeownership Production Program<br>• Building a More Resilient Housing System<br>• Building Codes Save: A Nationwide Study - Losses Avoided as a Result of Adopting Hazard-Resistant Building Codes<br>• Building Codes Strategy<br>• Building Equity into Federal Investments for Housing Resilience<br>• Final Report on the Back Home Rapid Housing Recovery Pilot Program<br>• Housing Policies that Save (and Improve) Lives, Protect Assets and Shield Economies<br>• Housing Resiliency Program Guide<br>• Mitigation Assessment Team Report - Hurricane Harvey in Texas: Building Performance Observations, Recommendations, and Technical Guidance<br>• Mitigation Assessment Team Report - Hurricane Ike in Texas and Louisiana: Building Performance Observations, Recommendations, and Technical Guidance | N/A | N/A |

| Data Being Utilized | Current Data Gaps | Exclusions |
|---|---|---|
| • Rapid Disaster Recovery Housing Program<br>• Resilient Retrofits: Climate Upgrades for Existing Buildings<br>• Rapid Disaster Recovery Housing Program - Technical Guide Appendix: Core | | |
| **Analysis of IBC/IRC Resiliency** | | |
| ***Subcomponent**: Analysis of IBC/IRC Resiliency* | | |
| ***Description:** An assessment of how IBC/IRC, specifically those I-Codes available at the time of the GLO CDBG-DR programs, have evolved over time.* | | |
| • 2018 IRC<br>• 2015 IRC<br>• 2012 IRC<br>• 2009 IRC<br>• 2006 IRC<br>• 2018 IBC<br>• 2015 IBC<br>• 2012 IBC<br>• 2009 IBC<br>• 2006 IBC | N/A | • I-Codes other than IBC/IRC were excluded from this analysis.<br>• IBC/IRC code provisions that were not comparable to the key construction specifications detailed in each of the GLO CDBG-DR programs were excluded from this analysis. |
| **Spatial Analysis** | | |
| ***Subcomponent**: CDBG-DR Funding by Activity Type* | | |
| ***Description:** An assessment of how CDBG-DR funding has been distributed for each individual disaster allocation across rehabilitation, reconstruction, and new construction housing programs to clarify the priorities of the GLO across disasters.* | | |
| • 2015 Floods HAP, ARP, and HRP<br>• Harvey HAP (Reconstruction, Rehabilitation), ARP, and HRP<br>• Ike Acquisition, Demolition, Down Payment Assistance, Reconstruction, and Rehabilitation | • 2016 Floods Housing Programs<br>• 2011 Bastrop Wildfires Housing Programs | • Outdated Contracts<br>• Lead-Based Paint safety worksheet |

| Data Being Utilized | Current Data Gaps | Exclusions |
|---|---|---|
| • Ike ex-HOP and HOP<br>• Rita ex-HOP, HOP, HAP, and HRP<br>• Dolly ex-HOP, HOP, HAP, and HRP | • 2018/2019 Floods Housing Programs<br>• Beneficiary Data under HAP, HRP, HARP, ARP, and RHP by disaster | • Duplicative data sets for housing programs<br>• Unconnected housing program data<br>• Project closeout letters<br>• Insurance forms<br>• Drafts of documents |
| ***Subcomponent:*** *Comparison of Subrecipients and Beneficiaries by Location, Disaster, and Program Activity Types* | | |
| ***Description:*** *A comparison of the geolocation of subrecipients and beneficiaries for rehabilitation, reconstruction, and new construction housing programs across various disasters impacting Texas.* | | |
| • Beneficiary data for the following housing programs: HAP, ex-HOP, HOP, HRP, and Homebuyer Assistance<br>• 2015 Flood Subrecipient data for the following counties: Grimes, Hidalgo, Hays, Jasper, Jim Wells, Newton, Travis, Willacy<br>• 2015 Flood Subrecipient data for the following cities: Austin, Bellaire, Bridgeport, Buda, Buffalo, Christoval, La Marque, Penitas, Raymondville, Clifton, Corpus Christi, Corsicana, Dawson, Freer, Hays, Hubbard, Jewett, Kyle, La Porte, Lyford, Navasota, Normangee, Nueces, Orange Grove, Pasadena, Petronila, Premont, Raymondville, Reno, Rice, Somerville, Travis, Williamson, and Wimberley<br>• 2016 Flood Subrecipient data for the following counties: Austin, Bastrop, Eastland, Grimes, Harris, Hidalgo, Jasper, Lee, Madison, Newton, San Augustine, and San Jacinto<br>• 2016 Flood Subrecipient data for the following cities: Bandera, Brenham, Buffalo, Baytown, Brazoria, Brenham, Brookshire, Buffalo, Clute, Eastland, | • 2016 Floods Housing Programs by beneficiary and subrecipient<br>• 2011 Bastrop Wildfires Housing Programs by beneficiary and subrecipient<br>• 2018/2019 Floods by beneficiary and subrecipient<br>• Beneficiary Data under HAP, HRP, HARP, ARP, and RHP by disaster<br>• Subrecipient data | • Outdated Contracts<br>• Lead-Based Paint safety worksheet<br>• Duplicative data sets for housing programs<br>• Unconnected housing program data<br>• Project closeout letters<br>• Insurance forms<br>• Drafts of documents |

| Data Being Utilized | Current Data Gaps | Exclusions |
|---|---|---|
| Elgin, Freeport, Houston, Jacinto City, Kingsville, Newton, Sweeny, Trinity, Zavalla, Clifton, Kleberg, Linden, Navasota, Pasadena, Oak North Ridge, Patton Village, Rosenberg, San Felipe, Sealy, Simonton, Stagecoach, Stephenville, Tomball, Tenaha, Travis, Wallis, Wharton, Willis, Woodloch, and Woodsville<br>• 2016 Flood Subrecipient data for the following organizations: Deep East Texas COG and Harris County Community Services Department<br>• Bastrop Wildfire Subrecipient data for the City of Bastrop<br>• Hurricane Dolly Subrecipient data for the South East Texas Regional Planning Commission<br>• Hurricane Ike Subrecipient data for the City of Galveston, Galveston County, and the Galveston Housing Authority.<br>• Hurricane Ike and Dolly Subrecipient Data for the following cities: Galveston, Houston, and Liberty<br>• A comprehensive data set of Hurricane Harvey subrecipients by city, county, and organization<br>• Hurricane's Katrina and Rita Subrecipient data for the City of Houston, Harris County, and South East Texas Regional Planning Commission | | |
| ***Subcomponent:*** *Repetitive Loss Properties* | | |
| ***Description:*** *An analysis of repetitive loss properties of CDBG-DR programs in Texas for programs carried out directly by the State, excluding subrecipient-led programs.* | | |
| Repetitive loss properties are determined through the spatial analysis of beneficiaries. | Beneficiary Data under HAP, HRP, HARP, ARP, and RHP by disaster | • Outdated Contracts<br>• Lead-Based Paint safety worksheet |

| Data Being Utilized | Current Data Gaps | Exclusions |
|---|---|---|
| | | • Duplicative data sets for housing programs<br>• Unconnected housing program data<br>• Project closeout letters<br>• Insurance forms<br>• Drafts of documents |
| **Loss Avoidance Study** | | |
| ***Subcomponent:*** *Loss Avoidance Study* | | |
| ***Description:*** *A detailed and targeted analysis of programs identified through the Spatial Analysis as having a statistically significant impact on reducing repetitive losses.* | | |
| • Policies utilized in programs identified as key to increasing resilience<br>• Types of programs being implemented (buyout, rehab, etc.)<br>• Construction specifications utilized in programs identified as key to increasing resilience<br>• Contextual factors that may have impacted the higher resilience (e.g., location, severity of disaster, social climate at the time, socio-economic status of the impacted region, existing mitigation projects in the region)<br>• Investment caps determined by United States Department of Housing and Urban Development (HUD)<br>• Duplication of Benefits as outlined in the Stafford Act<br>• Amount of money spent on repetitive loss properties | • 2016 Floods Housing Programs by beneficiary<br>• 2011 Bastrop Wildfires Housing Programs by beneficiary<br>• 2018/2019 Floods by beneficiary<br>• Beneficiary Data under HAP, HRP, HARP, ARP, and RHP by disaster | • Outdated Contracts<br>• Lead-Based Paint safety worksheet<br>• Duplicative data sets for housing programs<br>• Unconnected housing program data<br>• Project closeout letters<br>• Insurance forms<br>• Drafts of documents |

| Data Being Utilized | Current Data Gaps | Exclusions |
|---|---|---|
| • Estimated amount of money avoided on properties that would have experienced repetitive loss if it weren't for the resiliency measure implemented. | | |
| **Cost-Benefit Analysis** | | |
| ***Subcomponent:*** *Calculate Benefit-Cost Ratio (BCR)* | | |
| ***Description:*** *Cost-effectiveness will be determined by cost data relating to CDBG-DR program construction costs and resiliency benefits according to construction specifications.* | | |
| • Construction specifications mandated by HUD for CDBG-DR housing rehabilitation and reconstruction programs<br>• Construction specifications drawn from the IBC/IRC available at the time of the disaster<br>• Construction specifications for resilient housing drawn from academic and industry best practices<br>• Property values | N/A | N/A |
| **Analysis of GLO Programs** | | |
| ***Subcomponent:*** *Construction Specifications* | | |
| ***Description:*** *An assessment of construction specifications from GLO CDBG-DR programs against national practices.* | | |
| • Ike Housing Construction Specifications<br>• Ike Housing Design Standards<br>• 2011 Fires Bastrop County Complex Fire Housing Recovery Program<br>• 2011 Fires Home Building Services RFP<br>• 2015 and 2016 Housing Guidelines<br>• Harvey and 18-19 Construction Specifications | • The 2011 Bastrop Wildfires CDBG-DR program did not have a set of construction specification documents that could be utilized. | • The 2018 and 2019 Disasters CDBG-DR program was excluded from this analysis because it utilized the same construction specifications as the Hurricane Harvey program. |

| Data Being Utilized | Current Data Gaps | Exclusions |
|---|---|---|
| • Harvey and 18-19 Design Standards<br>• 2011 Fires TDHCA Residential Building Standards<br>• CSI MasterFormat<br>• Affordable Housing Construction Program Guide: Homeownership Production Program<br>• Final Report on the Back Home Rapid Housing Recovery Pilot Program<br>• Resilient Retrofits: Climate Upgrades for Existing Buildings<br>• Mitigation Assessment Team Report - Hurricane Harvey in Texas: Building Performance Observations, Recommendations, and Technical Guidance<br>• Mitigation Assessment Team Report - Hurricane Ike in Texas and Louisiana: Building Performance Observations, Recommendations, and Technical Guidance<br>• Rapid Disaster Recovery Housing Program<br>• Technical Guide Appendix | • The 2015 and 2016 Disasters CDBG-DR program did not have a set of construction specification documents that could be utilized.<br>• If a construction specification was missing from program documents, it is assumed that GLO utilized the matching regulation from the previous CDBG-DR program. | • Not all construction specifications implemented for the CDBG-DR programs were analyzed; only those that significantly indicate resilience were included in the analysis.<br>• Only codes from the IBC and IRC were utilized because they most closely align with CDBG-DR programs. Other components of the I-Codes (e.g., IBC, IECC) were consulted but not included in the quantitative analysis. |
| ***Subcomponent:*** *Policies and Procedures* | | |
| ***Description:*** *An assessment of GLO programs policies and procedures against federal standards.* | | |
| • Ike and Dolly Housing Guidelines<br>• 2015 and 2016 Housing Guidelines<br>• 2018 and 2019 Disasters Housing Guidelines<br>• Harvey Housing Guidelines<br>• FRN 5844 (Harvey and 2018-2019)<br>• FRN 41146 (Ike and Dolly)<br>• FRN 22583 (2011 Fires) | 2011 Bastrop Fires CDBG-DR program documentation was not available. | • Resources regarding the policies and procedures of the 2011 Bastrop Fires CDBG-DR program were not available, and therefore this program is excluded from the analysis.<br>• Not all policies and procedures implemented for the CDBG-DR |

| Data Being Utilized | Current Data Gaps | Exclusions |
|---|---|---|
| • FRN 39687 (2015-2016) | | programs were analyzed; only those that significantly indicate resilience were included in the analysis. |
| **Analysis of Peer State Programs** | | |
| ***Subcomponent:*** *Construction Specifications* | | |
| ***Description:*** *An assessment of construction specifications from Texas and peer state CDBG-DR programs.* | | |
| • Office of Long-Term Resiliency Hurricane Michael Policy Manual<br>• State of Florida Action Plan for Disaster Recovery<br>• Rebuild Florida Housing Repair & Replacement Program: Single-Family Owner-Occupied Guidelines<br>• The Restore Louisiana Homeowner Assistance Program Manual<br>• Restore Louisiana Green Building Standards Implementation Plan<br>• NY Rising Homeowners Program Guidebook<br>• NY Rising Housing Recovery Program Policy and Plan<br>• NY Rising Housing Recovery Program Elevation Design Guidance<br>• NY Rising Housing Program Extraordinary Site Conditions<br>• NY Rising Housing Program Maximum Design Criteria for Structural Elevation<br>• Harvey and 18-19 Construction Specifications<br>• Harvey and 18-19 Design Standards<br>• Mitigation Assessment Team Report - Hurricane Harvey in Texas: Building Performance Observations, Recommendations, and Technical Guidance | Peer state CDBG-DR programs did not have a set of construction specification documents that could be utilized; instead, construction specifications were aggregated from other resources developed for program implementation. | Not all construction specifications implemented for the CDBG-DR programs were analyzed; only those that significantly indicate resilience were included in the analysis. |

| Data Being Utilized | Current Data Gaps | Exclusions |
|---|---|---|
| ***Subcomponent:*** *Policies and Procedures* | | |
| ***Description:*** *An assessment of policies and procedures from Texas and peer state CDBG-DR programs.* | | |
| • NY Governor's Office of Storm Recovery (GOSR) Good Faith Efforts Guidelines<br>• GOSR Section 3 Greatest Extent Feasible Guidelines<br>• NY Rising Homeowners Program Guidebook<br>• NY Rising Housing Recovery Program Policy and Plan<br>• GOSR Procurement Policy Manual<br>• Office of Long- Term Resiliency Hurricane Michael Policy Manual<br>• Rebuild Florida Housing Repair & Replacement Program: Single-Family Owner-Occupied Guidelines<br>• Restore Louisiana Green Building Standards Implementation Plan<br>• The Restore Louisiana Homeowner Assistance Program Manual<br>• FRN 4681<br>• FRN 14329<br>• FRN 45838 | N/A | Not all policies and procedures implemented for the CDBG-DR programs were analyzed; only those that significantly indicate resilience were included in the analysis. |
| **Analysis of Economic Impact** | | |
| ***Subcomponent:*** *Analysis of Economic Impact* | | |
| ***Description:*** *An analysis conducted to understand potential economic impacts of adopting resilient codes on individuals, codes, and developers.* | | |
| • FRN 6364<br>• 2019 State Action Plan<br>• CDBG Disaster Recovery Overview<br>• 2020 Mitigation Application | • Texas-specific data outside of Dallas was not available, so there is a limited geographic scope. | N/A |

| Data Being Utilized | Current Data Gaps | Exclusions |
|---|---|---|
| • Before You Apply for BRIC Funds<br>• Before you Apply: Things to Know and Do Before for Hazard Mitigation Grant Program Funds<br>• Community Development Block Grant Mitigation Program | • Additional costs of code compliance for coastal flooding are not considered in some of the reports, and therefore excluded from this analysis.<br>• Additional costs are not available for reference houses, and therefore have been substituted with location-specific costs of code compliance. | |