Design-Level Events and Residential Construction Performance: Hurricane Laura Case Study

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Introduction

Just one hurricane season demonstrates the staggering toll climate-driven hazards can have on the 40% of the nation's population living in coastal counties [1]. Thus, there is an urgent need to minimize these losses and threats to human life by improving the performance of the built environment.

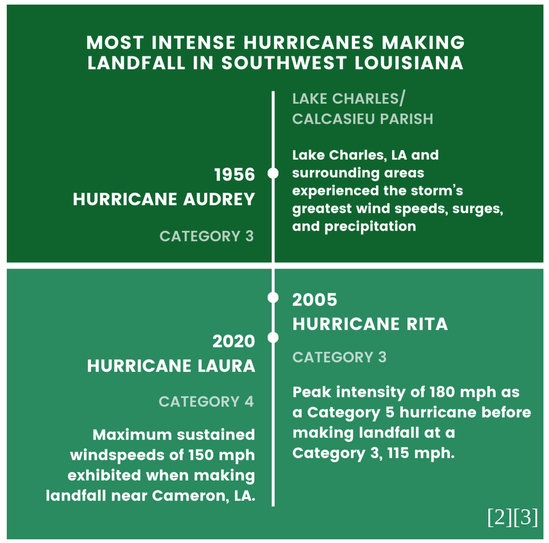
Study Zone:

- Hurricane Laura (2020) is a well-documented design-level wind event that can be used to systematically validate efficacy of Louisiana's building codes.
- Emphasis is placed on the evolution of code amendments post-Hurricane Rita (2005) in order to investigate what role these code revisions played in the observed performance in Hurricane Laura.

Significance:

- Building codes are the primary mechanism to mitigate hurricane risk in coastal residential infrastructure alongside zoning policies and insurance provisions.
- This study demonstrates how design-level events can dramatically accelerate our understanding of the effectiveness of regulatory mechanisms in securing the safety and functionality of our infrastructure.

Background



Our analysis operates under the assumption that any home built the year after a new code release and up to the year of the next code release is bound by that code.

The city of Lake Charles currently implements the following codes as of January 1, 2015:

- 2015 International Building Code (IBC)
- 2015 International Residential Code (IRC)
- 2015 International Existing Building Code (IEBC)

Methodology

Our analysis is organized according to the hurricane loss estimation stages followed by the NHERI SimCenter [4] and informed by FEMA HAZUS-MH.

A. Asset Description

Identify candidate homes based on construction material (wood), occupancy (residential), number of stories (1-2), year built and availability of SimCenter and StEER data.

B. Hazard Characterization

Narrow candidate homes to only those exposed to design wind speeds as estimated by Applied Research Associates.

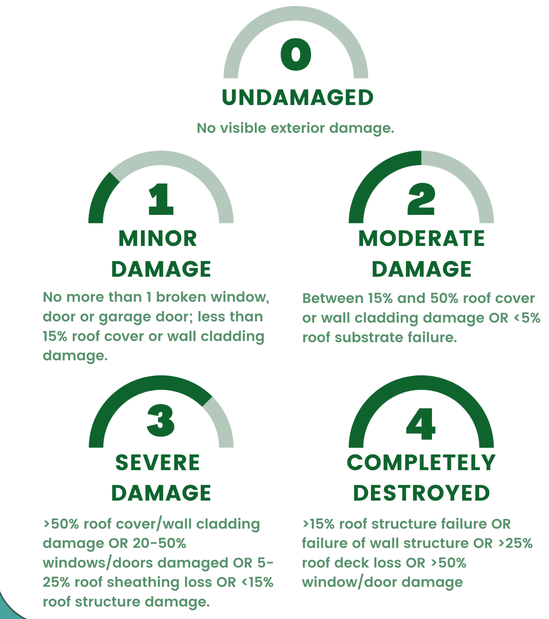
C. Asset representation

Segment candidate homes by building code era to randomly sample 30 homes in each era. Use NHERI SimCenter building inventory to assign attributes likely correlated with damage levels per HAZUS-MH for Wood Residential Construction:

- SWR: Secondary Water Resistance (roof system)
- RoofCVr: Roof Cover type
- RoofQual: Quality of roof cover
- RDA: Roof Deck Attachment type (for wood roofs)
- R2WC: Roof-to-Wall Connection type
- Shutters: presence of window protection
- Agarage: Attached garage presence and quality
- Terrain: terrain class (roughness) based on Land Use Land Cover (LULC) data

D. Damage and Loss Estimation

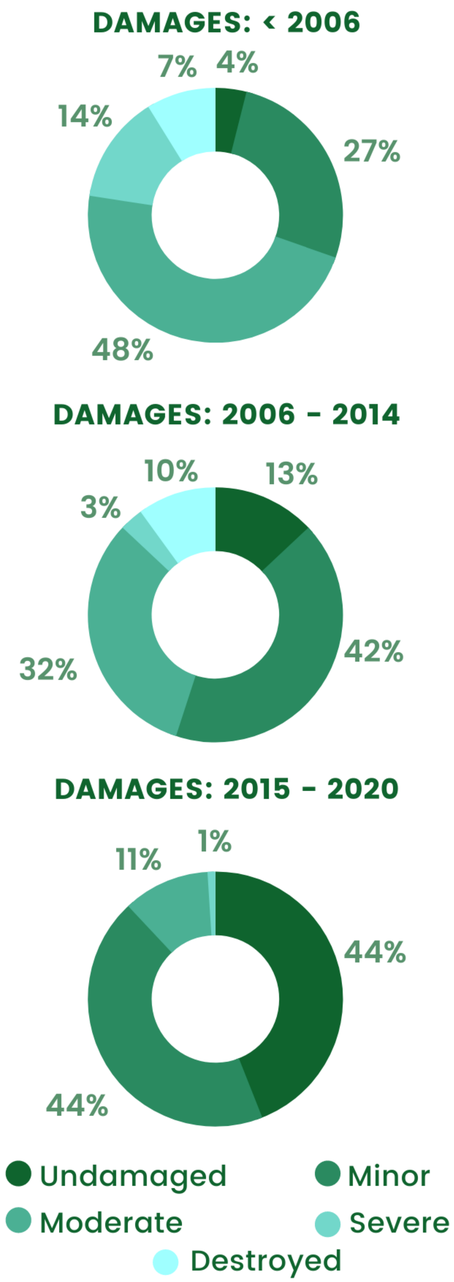
Use StEER field observations and satellite imagery to assign HAZUS-MH Damage States (0-5) to each home.



Preliminary Results

The preliminary results on damage severity are organized by building code era:

- Before 2006 (buildings constructed before Hurricane Rita)
- Between 2006 and 2014 (post-Rita construction guidelines)
- 2015 to present (buildings constructed under current codes (2015) until Hurricane Laura (2020))



Discussion

Building codes are intended to reduce direct and indirect losses in design-level events. Enhanced construction standards, such as those adopted by the state of Florida in 1996, prevent building damage, resulting in a 60% reduction in the number of claims and a 42% reduction in claims payouts [5]. Moreover, the latest model codes would curb wind damage in new properties for a benefit-cost ratio of 10:1 [6]. However, these benefits are realized only when states adopt and enforce the latest model codes – this is not the case in many hurricane-exposed states [7].

Using Hurricane Laura's impacts on Louisiana as a "living laboratory" we have preliminary evidence that buildings constructed using the 2015 edition of the building codes had markedly lower rates moderate to severe damage in Hurricane Laura than buildings built using prior editions of the code.

Continuing Research

To verify that code requirements were responsible for this improved performance, rather than other factors such as material deterioration, the ongoing analysis will examine how the attributes of each building contributed to the observed damage and identify correlations with specific code amendments since 2005 to establish if these regulatory mechanisms are providing the intended levels of protection in design-level wind events and make recommendations on the attributes that should be addressed in future amendments of the codes in Louisiana.

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Acknowledgements

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