Wind Risk Mitigation Through Infrastructural Adaptation Across Past, Present, and Future Climates

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Introduction

Climate change has increased the frequency and intensity of extreme weather events (Fischer and Knutti 2015; Liu et al. 2026).

In this context, extreme event attribution (EEA) science plays a critical role, as it allows researchers to quantify **whether, and to what extent, climate change has made extreme weather events more severe**.

EEA research on hurricanes which assesses the degree to which climate change has intensified hurricane impacts, is characterized by two key research gaps:

(1) Studies have predominantly focused on precipitation-related impacts, with limited attention to wind damage despite wind being a key source of damage.

(2) Despite efforts to implement enhanced building codes their potential to offset climate change–driven impacts remains overlooked.

Therefore, **using the case of Hurricane Ida in South Louisiana, our research examines:**

- **wind-related damages attributable to climate change**
- **the extent to which the enforcement of enhanced building codes may have mitigated them.**

Study area

- **20** parishes and **716** census tracts in Southern Louisiana
- We modeled wind damage for all residential buildings based on **building attributes, surface roughness, and wind speed** using the **Hazus damage loss function**

- Damage was estimated under current and universal building code adoption rates for three climate scenarios:

Mitigation Intervention	Current Adoption	Universal adoption
Enhanced roof deck attachment	42.3%	100%
Secondary water resistance	20.31%	100%
Shutters on doors and windows	0%	100%
Roof to wall connection	78.41%	100%

1971
No warming
"The storm that could have been"

2021
Current warming
"The storm that was"

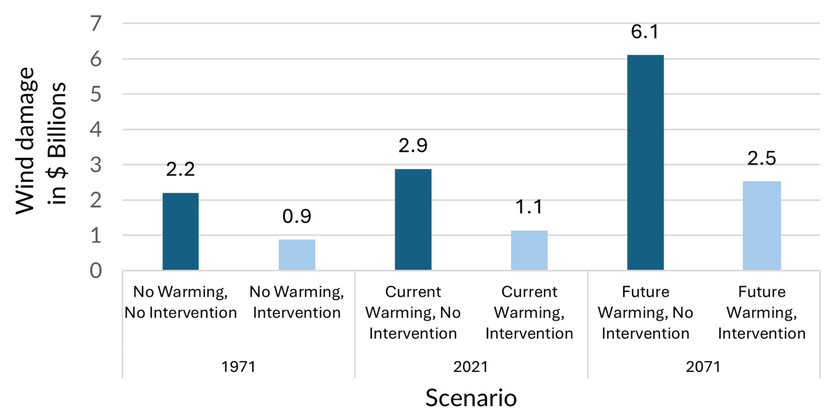
2071
Future warming
"The storm that could be"

Research questions and findings

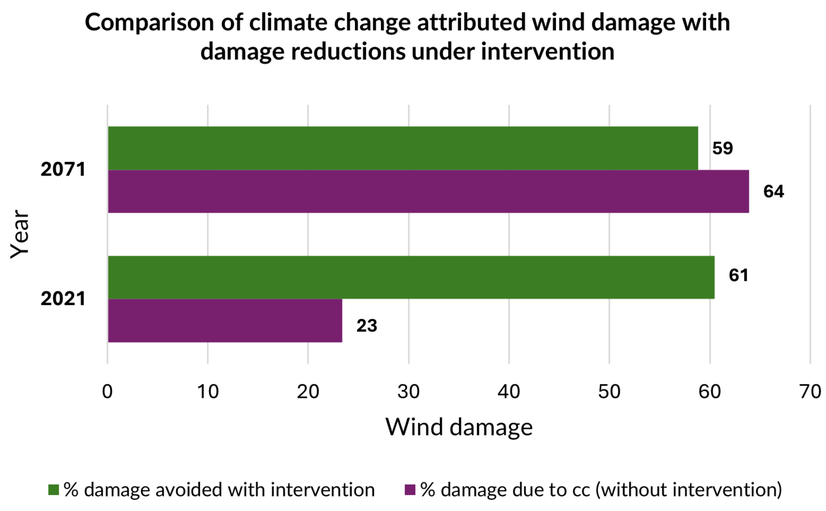
Research question 1:To what extent are wind-related damages from Hurricane Ida attributable to climate change?

- Total estimated wind damage from Hurricane Ida in 2021 was **$2.9 billion**, **31%** higher than the no-warming estimate of **$2.2 billion**.
  - ➢ This also means: of the estimated damages, approximately **$671.5 million (23%)** is attributable to climate change.
- Under future climate conditions, wind damages are projected to reach **$6.1 billion**, **177%** higher than the 1971 baseline and **112%** higher than 2021 damages.
  - ➢ This also means: of the projected damages, approximately **$3.9 billion**, or **64%**, is attributable to climate change.

Estimated wind damage under pre, current and future climate scenarios with and without intervention



Comparison of climate change attributed wind damage with damage reductions under intervention



Research questions and findings

Research question 2: What effect would enhanced building codes have had on wind impacts during Hurricane Ida and a stronger Ida-like storm in the future, and to what extent could these mitigation benefits offset climate change–driven damages?

- Under contemporary climate conditions, building code interventions would have reduced wind damage by **$1.74 billion or 60%.**
  - ➢ Here, building code interventions would not only fully offset damages attributable to climate change but also reduce an additional **$1.1 billion** in damages, approximately **48%** of the remaining non-climate change related damage.
- Under future warming, these interventions would reduce damages by an estimated **$3.6 billion or 58.8%**.
  - ➢ Here, building code interventions would mitigate **92%** of the climate change-attributable damages projected for 2071, substantially, but not fully offsetting the impacts of climate change.

Conclusions

- Climate change amplified wind damage from Hurricane Ida and is projected to further increase damages from future Ida-like storms.
- Under contemporary climate conditions, building code interventions would have fully offset increases in wind damage.
- Under future climate conditions, interventions would still substantially reduce wind damage, but without fully offsetting climate change-attributable increases.
- Notably, in both a world with and without intervention, climate change increases wind damages.
- In fact, the world with future warming and intervention has greater damages than the world with no warming and no intervention.

Limitations

- We do not account for over time variations in buildings.
- Results are based on an ideal scenario of universal adoption.

Policy implications

- Investing in and subsidizing the implementation of enhanced building codes may substantially mitigate future climate change effects.
- Building codes should be updated to account for projected future climate conditions.
- Combined implementation of climate change mitigation efforts aimed at reducing warming and adaptation strategies, such as enhanced building codes could be a more effective way forward.

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