Community-Informed Building-Scale Resilience Assessment

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Untapped Potential for Resilience

It is widely known that natural hazards, like hurricanes, cause tremendous levels of damage and that hazard mitigation can significantly curb natural hazard-induced losses. However, necessary investments are still needed for the widespread implementation of hazard mitigation practices. We believe that this lack of investment stems from the underestimation of potential losses by present tools, which discount the effect of community characteristics on losses accrued by individual households.

This brief presents a framework that incorporates community characteristics like urban texture to enable a community-informed building scale resilience assessment. With this framework, stakeholders will be able to capture the true value of hazard mitigation practices.

Redefining Drag Coefficients

Methods for loss estimation are based on defining a hazard, like wind loads from hurricanes, and evaluating its impact on the performance of structures and then on the losses accrued by communities and individual households. Hurricane wind loads, in particular, depend on two factors: wind speeds and drag coefficients. Wind speeds

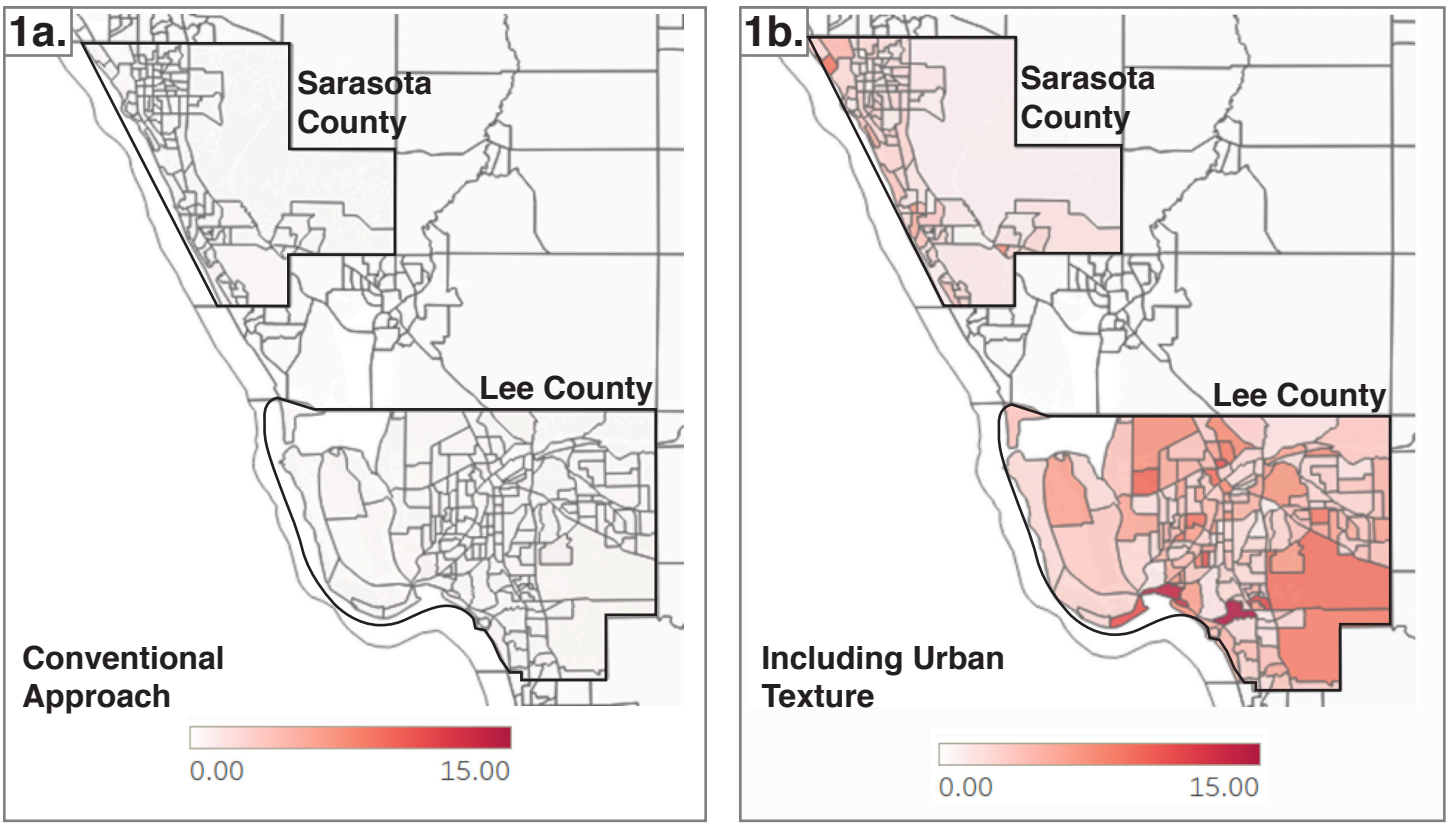

Figure 1: 95%-ile annual expected losses for households as a percentage building value using conventional loss estimation **(1a)** and loss estimation with county-specific textures **(1b)**.

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are probabilistic and are predicted based on historical records, while drag coefficients refer to a structure's wind resistance and are assumed constant in practice.

However, CSHub studies have found that building drag coefficients aren't constant but instead depend on urban texture, or the relative orientation of surrounding buildings. Urban texture creates localized pockets of amplified wind loads, increasing natural hazard-induced damage. Specifically, the more ordered a city's texture, the greater the wind loads its structures will likely experience.

Here, we implement a CSHub model to quantify and map the additional potential losses caused by urban texture. We aim to demonstrate how urban texture modeling reveals the magnitude by which present tools underestimate potential losses.

Enhanced Loss Estimation

Figure 1 displays the 95%-ile annual expected losses—the losses incurred during an abnormally destructive hurricane season—for households in census tracts in Sarasota and Lee County, FL.

Though similar in building stock and hazard risk, these counties differ in terms of urban texture: Lee County possesses a more ordered texture while Sarasota possesses a less ordered texture. The impact of these differences in texture became evident during Hurricane Irma in 2017, in which Lee County experienced greater levels of damage than Sarasota County.

When looking at the 95%-ile of natural hazard events, which better reflect phenomena of high category hurricanes such as Irma, we see a clear rise in annual expected losses for households. Not considering urban texture places annual expected losses at 1.1% of building value (4.9% of household income) in Lee County and 0.8% of building value (4.3% of household income) in Sarasota County (**Fig. 1a**). Incorporating a generalized texture increases these values to 1.7% (7.0%) in Lee County and 1.1% (5.8%) in Sarasota County. Furthermore, incorporating county-specific textures raises the losses to 4.0% (16.5%) in Lee County and 1.8% (9.8%) in Sarasota County (Fig. 1b). This increase captures how the texture effect can magnify losses and how these losses vary depending on the texture of a community.

To mitigate these losses, stakeholders should use the city texture model to design more comprehensive building codes and resilient developments. In the process, they will be able to minimize wind simulations and more rapidly locate vulnerable buildings for retrofit.

The next step will be incorporating demand surge into this framework. Demand surge refers to the increase in market prices due to demand for materials and labor exceeding the local supply following large-scale natural hazard events. It is a significant, but often overlooked, opportunity for disaster mitigation.

Key Findings:

- In contrast to conventional practices, CSHub has found that hazard wind loads vary by urban texture.
- By not accounting for urban texture-induced wind load amplifications, current methods can, in some cases, underestimate losses during extreme hazard events by nearly a factor of three.
- Using a city texture model can streamline hazard mitigation and create more resilient communities.

Related Links:

- Break-even Mitigation Percent Dashboard
- Research Summary: Life Cycle Costs of Hazard Resistant Buildings

Citation:

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