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Hurricane Risk Assessment for Coastal Residential Buildings Considering Climate Change

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RCEU 2022 Project Proposal

Project Title

Hurricane Risk Assessment for Coastal Residential Buildings Considering Climate Change

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I. Project Description

Hurricanes are among the most devastating natural hazards in the U.S., threatening communities, ecosystems, and infrastructures. Hurricanes have caused average normalized damage of US$ 10 billion annually in the continental U.S. over the past century. Almost 40% of the U.S. population lives on coastal shorelines prone to hurricanes, and more people are expected to continue to move to such areas. Recently, there have been more destructive and intense hurricanes (e.g., Ida (2021), Laura (2020), Michael (2018), Harvey (2017), and Irma (2017)) that have ravaged the coastal areas of the U.S., causing extensive damage to buildings and infrastructures. There is evidence that the intensity of hurricanes has been increasing in recent years due to climate change. This is partly due to rising sea surface temperature (SST), as seen in **Figure 1**. The formation and intensity of hurricanes are directly tied to SST. Hence, rising SST is expected to lead to more intense hurricanes.

More than 90% of the residential buildings in the U.S. are wood-frame construction. Such construction is particularly vulnerable to damage due to hurricanes, resulting in billions of dollars in losses. Such losses are expected to increase as the intensity of hurricanes increases due to climate change. There is, therefore, a need to estimate the increase in hurricane damage to residential buildings due to climate change. Such estimation will allow owners and decision-makers to evaluate the cost-effectiveness of various strategies available to strengthen residential construction and reduce the risk posed by hurricanes. Strategies that seem expensive now can be cost-effective if the future increase in losses due to climate change is considered.

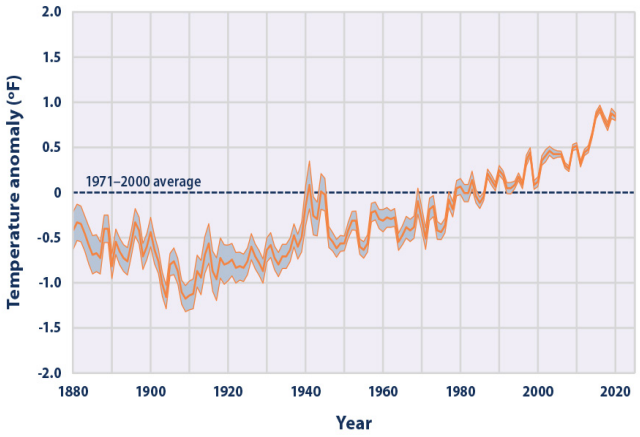

Figure 1: Changes in SST (source: EPA, NOAA)

The **goal** of this project is to quantify the potential increase in hurricane-induced losses to residential buildings due to climate change. Specific **objectives** include (i) quantifying the structural damage and associated monetary losses to residential buildings due to hurricanes under current climate conditions and (iii) estimating the structural damage and associated monetary losses to residential buildings at the end of the 21st century under different climate change scenarios.

II. Student Duties, Contributions, and Outcomes

a. Specific Student Duties

The student will use HAZUS, a software developed by the Federal Emergency Management Agency (FEMA), to estimate hurricane damage and associated losses to residential buildings in

Mobile, Alabama, under current climate conditions. The student will then use data that will be provided to estimate the increase in hurricane wind speed under future climate scenarios. Finally, the student will estimate the increase in losses to residential buildings under future climate scenarios using a basic risk assessment method.

b. Tangible Contributions by the Student to the Project

A Ph.D. student, Babak Salarieh, has been working on studying the impact of climate change on future hurricane damage to buildings and infrastructure systems in coastal areas of the U.S. The student has developed a comprehensive hurricane simulation model that incorporates the impact of rising SST on future hurricane intensity. One objective of the research is to evaluate the cost-effectiveness of implementing various risk mitigation strategies to reduce future hurricane losses to buildings and infrastructure. The RCEU student will use the results of the hurricane simulation model to specifically predict changes in hurricane-induced losses to residential buildings due to climate change. The results will be one of the inputs in evaluating the cost-effectiveness of the risk mitigation strategies.

c. Specific Outcomes Provided by the Project to the Student

At the end of the project, the student will learn (i) the basics of the risk assessment process as it applies to structures subjected to natural hazards, (ii) hurricane hazard analysis considering changes in SST, (iii) vulnerability assessment of residential buildings under hurricane wind loading, (iv) how climate change impact is incorporated into risk assessment, and (v) regional loss estimation using the HAZUS software.

III. Student Selection Criteria

The project is open to all engineering students that have taken a basic probability and statistics course.

IV. Project Mentorship

To successfully complete the project, the student needs to gain knowledge of the principles of risk assessment as well as learn how to use the HAZUS software. Dr. Salman will be responsible for ensuring that the student gained the necessary knowledge. This will be achieved through one-to-one discussions with the student twice a week and by providing the student with relevant literature to review. In the first two weeks of the project, Dr. Salman will teach the student the basics of risk assessment using simple examples. That will include the basics of hazard analysis, vulnerability assessment, and consequence analysis. The Ph.D. student currently using the HAZUS software for his research will train the student on the use of the software. The Ph.D. student will be designated as an adjunct mentor on the project. For the duration of the project, the student will share an office with the Ph.D. student.