Gis Modelling of Urban Flood Prone Areas

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Introduction

The current trend of sea-level rise and climate change is a threat for coastal areas. GIS modelling of an urban area can guide policymakers to take informed decisions on planning and infrastructure development.

Using the FUNWAVE model on nearshore [1], we modeled two different wave and storm surge flooding scenarios for New Haven Harbor, 10-year and 100-year return period.

Through the output of the flood simulations using GIS, we estimated the amount of water on the streets (including sidewalks and parking), buildings, and lifelines.

Using the ADCIRC MODEL focused on how the number of properties affected by the flooding changes around the New Haven Tweed Airport area under different implementation of flood control structure.

The study aims to increase the understanding of the flooding in urban areas by preparing communication tools via maps.

Methodology

Using a high-resolution wave model **FUNWAVE** we simulated four flooding scenarios:

- **Return period** for a **10-year** flood event
- **Return period** for a **10-year plus 20 inches** flood event
- **Return period** for a **100-year** flood event
- **Return period** for a **100-year plus 20 inches** flood event

The resulting **flood depth maps** were analyzed with Python, arcpy library, to see how streets, buildings, and lifelines are going to be affected. The raster is transformed in a shapefile and classified using Matlab. To classify flooded streets, we used the Pennsylvania DOT guidelines.

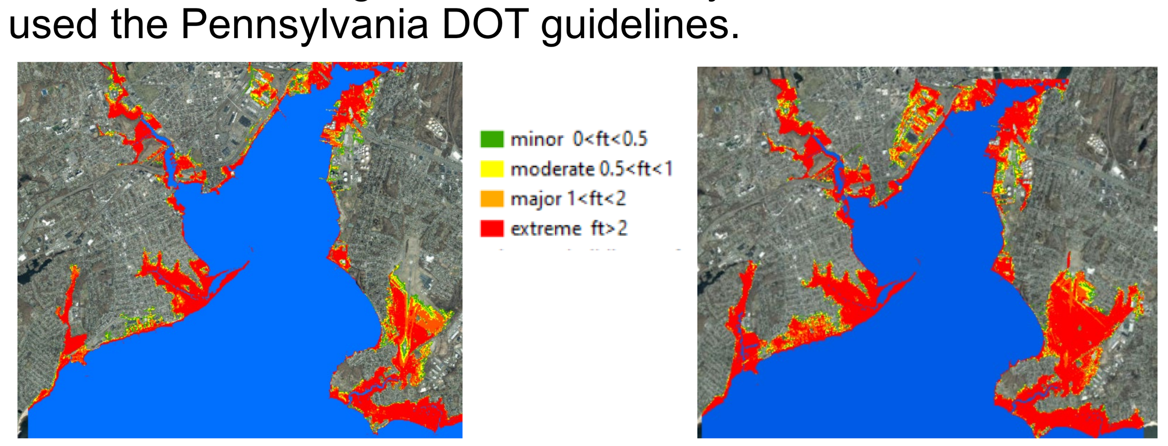

Figure 1 New Haven Harbor, flood depth maps 10 years + 20 inches vs 100 years + 20 inches.

Using **ADCIRC** we studied the different impacts that a major flood event could have (peak water level set at 2.6 meters, Hurricane Sandy) with or without **flood control structures:**

- Case0: current situation, **no flood control structure**
- Case1: Flood control structure implemented across **Morris Creek** and **Farm River**
- Case2: Flood control structure implemented across **Morris Creek**, **Farm River**, and along **Morris Cove**

Results

Maps and data analysis on the different impacts on **Streets**, **Buildings** and **Lifelines** according to the four cases run with **FUNWAVE**

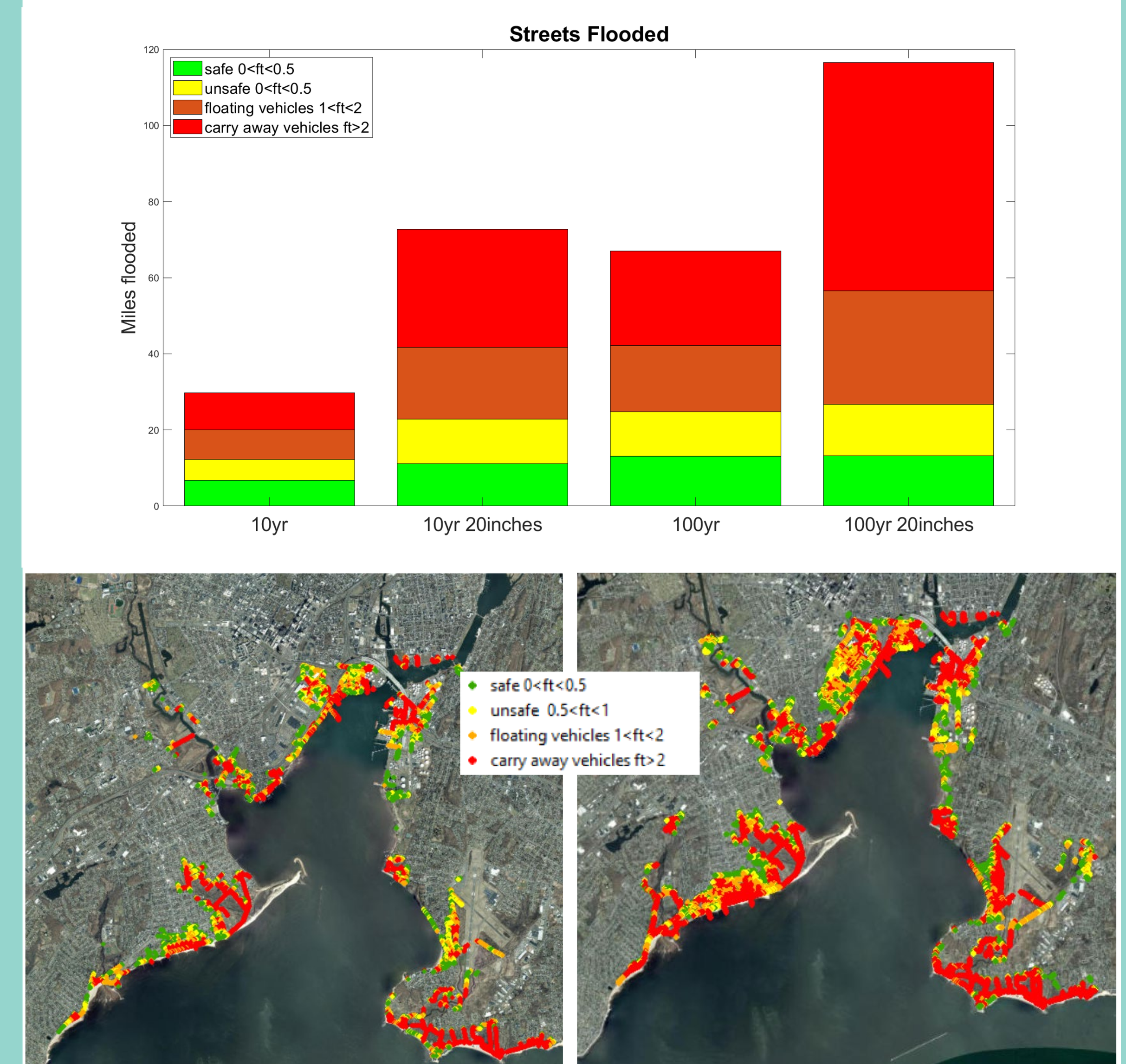

Figure 2 New Haven Harbor, streets flooded: 10 years + 20 inches vs 100 years + 20 inches.

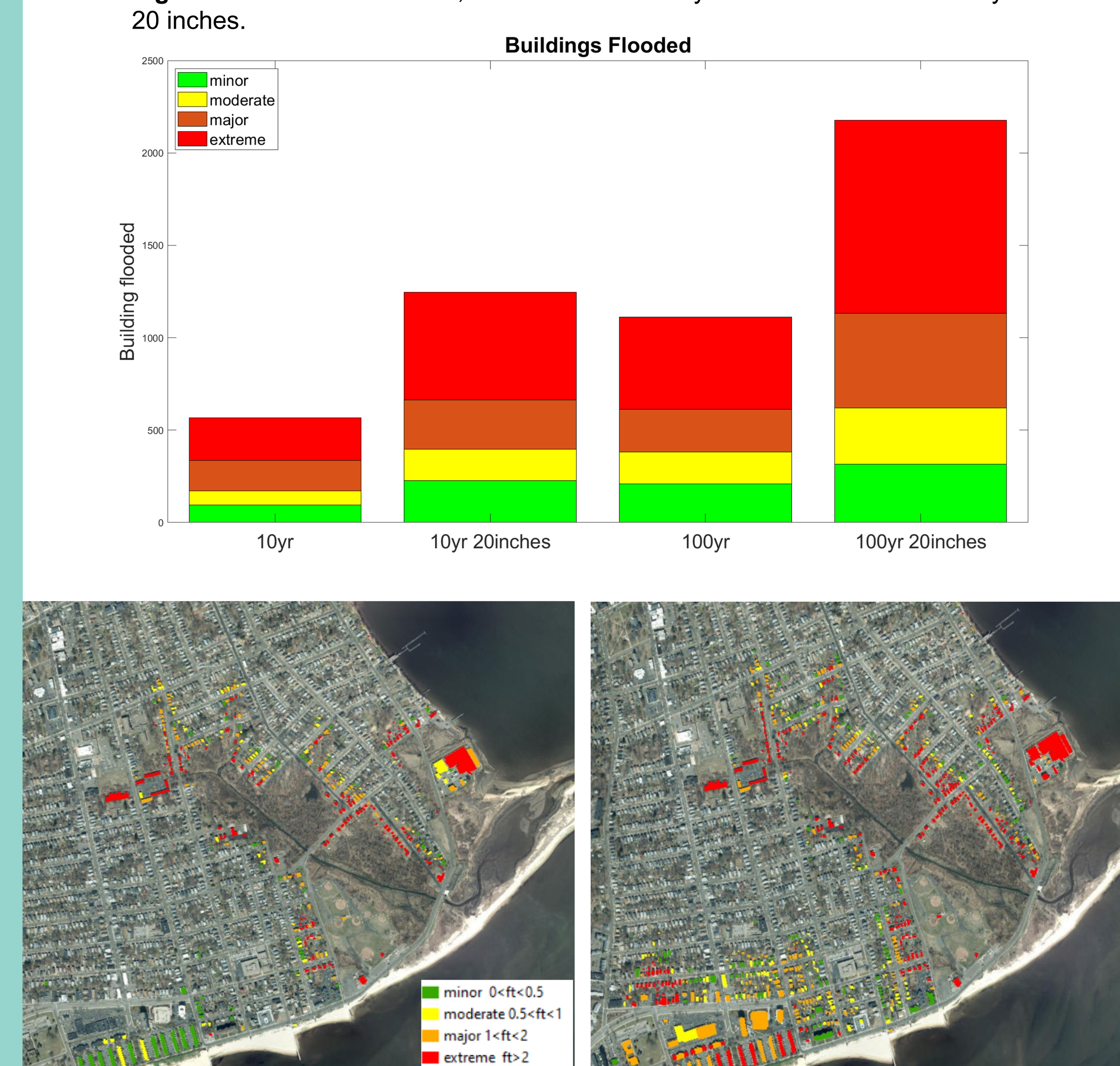

Figure 3 New Haven Harbor, zoom on West Haven, buildings flooded: 10 years + 20 inches vs 100 years + 20 inches.

A lifeline enables the continuous operation of government functions and critical business and is essential to human health and safety or economic security.

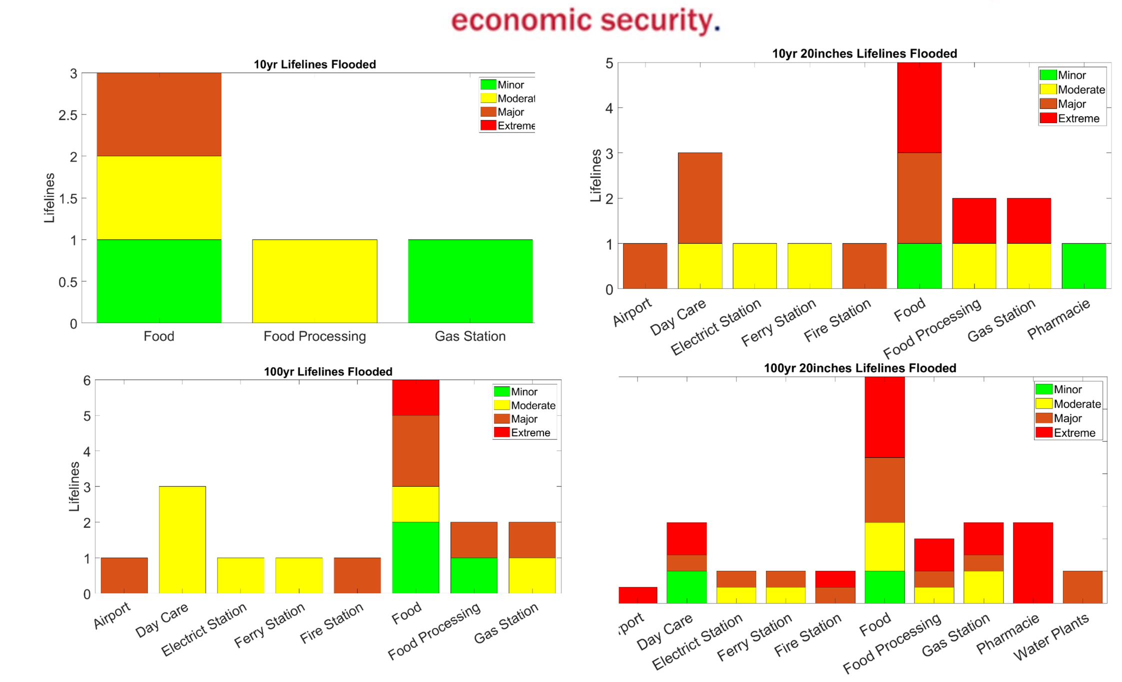

Figure 4 New Haven Harbor, lifelines flooded: 10 years + 20 inches vs 100 years + 20 inches.

By implementing flood control structures, it is possible to attenuate flood extension and damages. Following, the impact analysis of three possible scenarios generated by **ADCIRC**

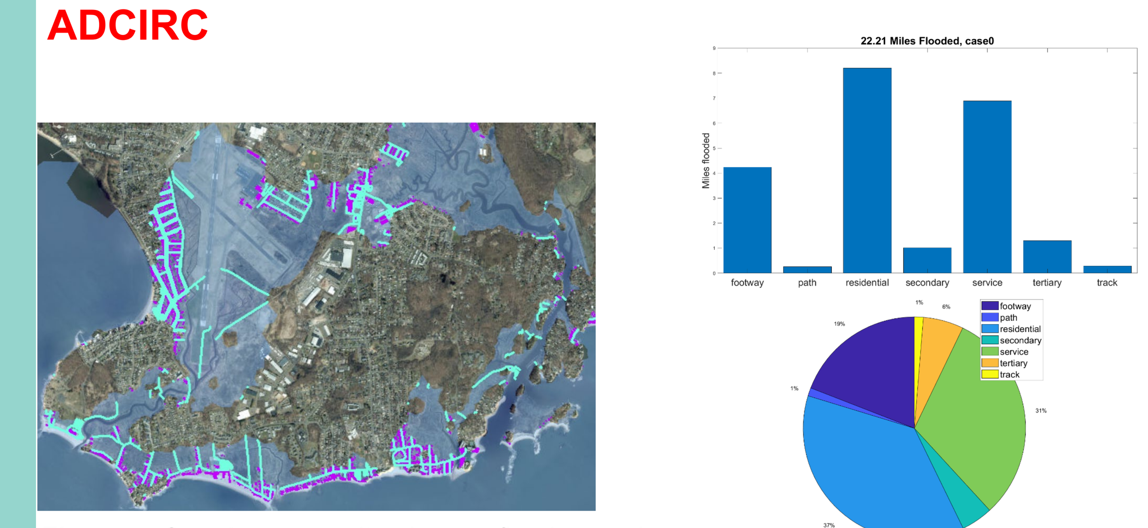

Figure 5 Case0: current situation, no flood control structure.

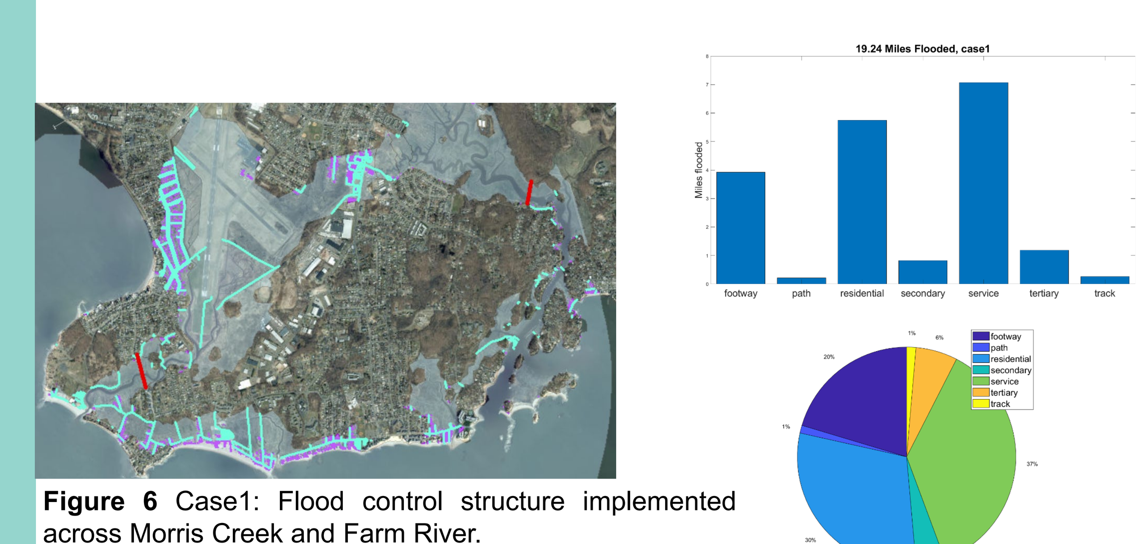

Figure 6 Case1: Flood control structure implemented across Morris Creek and Farm River.

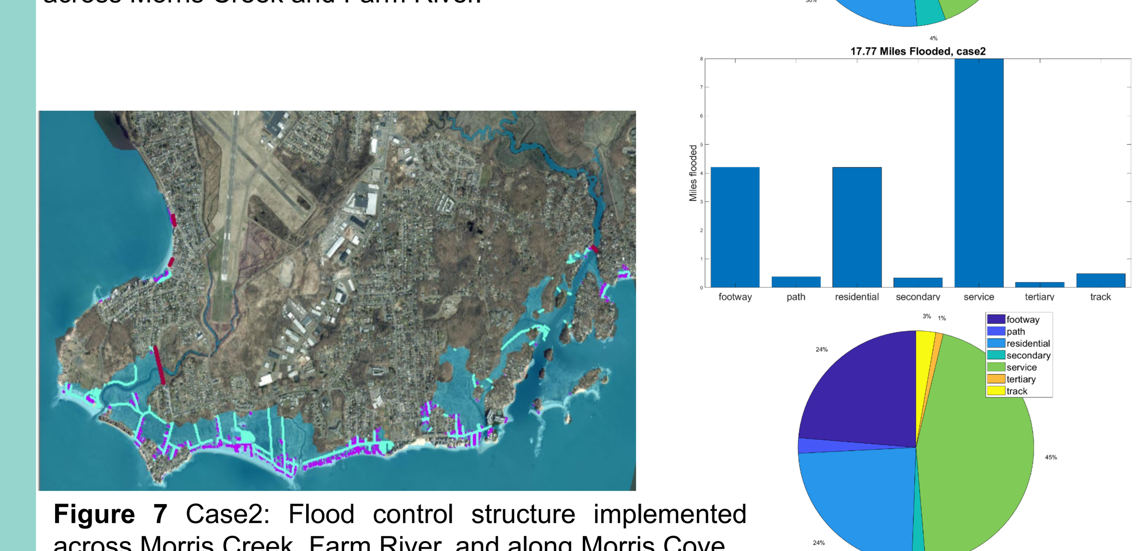

Figure 7 Case2: Flood control structure implemented across Morris Creek, Farm River, and along Morris Cove.

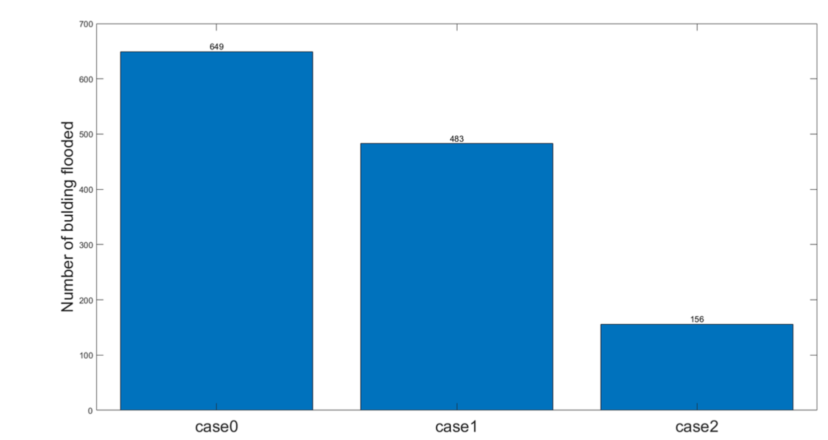

Figure 8 Comparison of the number of flooded buildings between the three case studies.

Conclusions

Increasing the flood event severity, from a return time of 10 years up to 100 years plus 20 inches, the number of affected features (Streets, Lifelines, and Buildings) increases.

The simulation with return period of 10-year plus 20 inches, which represents the sea level rise projection for 2050, shows destructive results.

Different actions can be taken in order to protect the New Haven Harbor area. The results from ADCIRC simulations show that the implementation of a flood control structure could help New Haven airport area in cushioning a flood event. Implementing Case 1 would lead to a 25.5% decrease of flooded buildings and to a 13.4% decrease of flooded roads. Implementing Case 2 would lead to a 76% decrease of flooded buildings and to an almost 20% decrease of flooded roads.

References

[1] Liu, C., Onat, Y., Jia, Y., O'Donnell, J. (2021) Modeling nearshore dynamics of extreme storms in complex environments of Connecticut. Coastal Engineering, 168(2021):103950, doi:10.1016/j.coastaleng.2021.103950

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