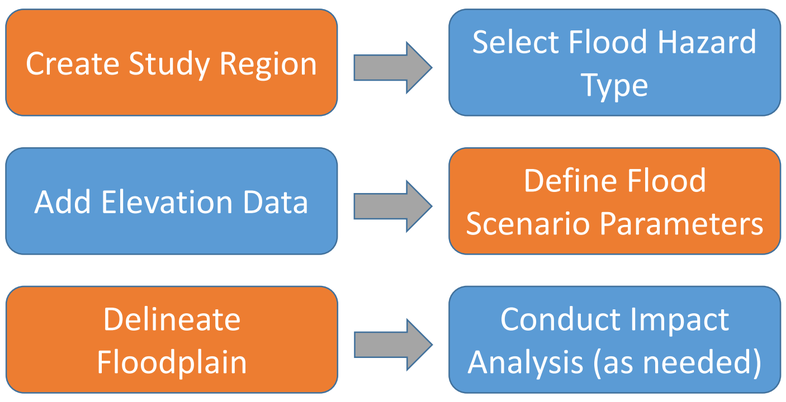
Introduction

In 2016, a joint grant project was initiated between the University of Florida, Stetson University, the East Central Florida Regional Planning Council (ECFRPC), and the City of Satellite Beach. Its goal is to improve data availability and quality for local officials in Satellite Beach to support informed policy decisions in the face of rising rea levels and increased impact from coastal flooding events. Using various research methods and geographic information system (GIS) tools, investigators at Stetson and UF have been working with local and regional stakeholders to identify areas of information need and how to address those needs.

The UF team has worked with the GIS flood modeling software Hazus-MH 3.1, a package developed by the Federal Emergency Management Agency (FEMA) as an add-on to ArcGIS software. Hazus has a reputation for being buggy and finicky, making it challenging to run even the most basic analyses. However, the outputs from the software can be very useful for local officials and stakeholders. For example, a set of key outputs are flood depth grids, which describe flood depths across a specified study area. Local officials can glean valuable information from there outputs, including identification of areas where assistance may be most needed during a storm, where infrastructure improvements are critical, and what areas may need to be abandoned in the future.

In addition to flood grids, Hazus can generate economic impact estimates for a given flood event. These outputs are only rough numbers based on aggregations and estimations at the census block level. Impact analysis outputs are not presented here, but this software functionality may be used in conjunction with other analyses to compare flooding impacts.

Using these outputs will help us understand areas that are at risk. Understanding areas of particular risk can aid in disaster response. In addition, future development in the community can be directed away from areas which have a higher propensity for dramatic flooding.

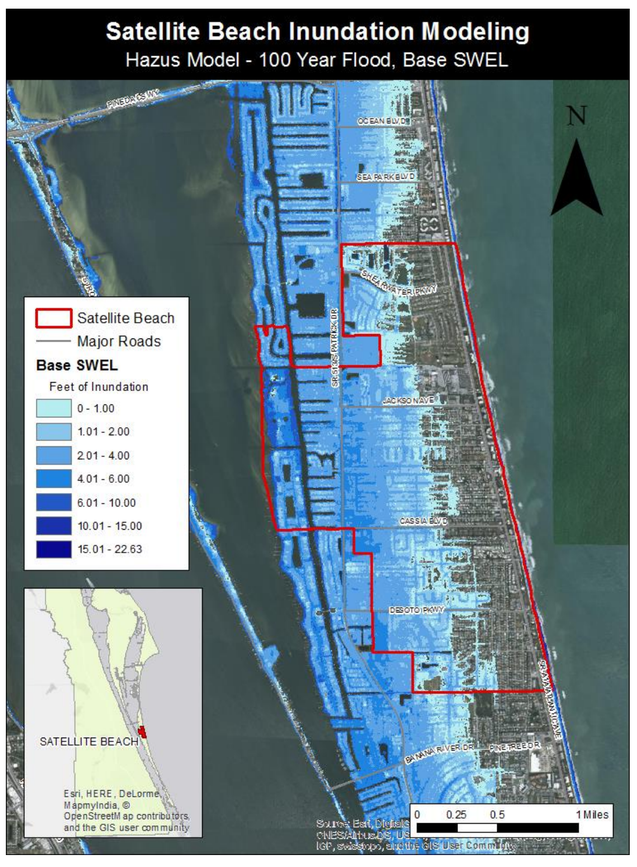


Methodology

Modeling coastal flooding using Hazus-MH is a relatively straightforward process with defined steps, as seen in the diagram below. But it also offers a large degree of customizability if desired by the user. It is easy to use the out-of-the-box offerings to do a quick, basic analysis. However, with more accurate and detailed data users can generate higher quality outputs. In this study a combination of out-of-the-box and higher quality input was used. The outputs generated are preliminary.

Here are the steps described in greater detail:

- To begin the process, a study region is selected using state, county, or census designations. In this case, twenty-one census tracts were used to define the study area centered on Satellite Beach.
- Then, the coastal flood hazard type was selected.
- Next, elevation data was added. The elevation used was a combination of NED 1/3 arc-second digital elevation model (DEM) (9m cell size) and Flidar DEM (5m cell size), a dataset maintained by GeoPlan. These two DEMs were combined so that Flidar was the default used, but any gaps in the dataset were filled in with the NED.
- Then, the flood scenario parameters were defined. A 100-year coastal flooding event (1% annual chance) was used as the basis for analysis. The desired coastline was selected and the stillwater elevation (SWEL) for a 100-year event entered by the user. Here, the default coastline was selected and the 100-year SWEL of 8.7 ft derived from the Flood Insurance Study for Brevard County. The 100-year SWEL varied depending on the model run. Each scenario was run using Wave Setup as a parameter, which helps account for wave effects in storm surge modeling. Multiple scenarios were run to include projected sea level rise, with values derived from Army Corps of Engineers projections used by East Central Florida Regional Planning Council for 2040, 2070, and 2100. These projections were added to the base SWEL.
- With all of the required parameters entered, the delineate floodplain step can be run. The output of this step is a raster dataset which shows the flooded area in the study region. The cell size of the output raster is the same as the DEM used as the input.
- Finally, a mask was used to enhance visualization of the resulting floodplain rasters. The mask was used to limit representation of the the floodplain raster to land areas.



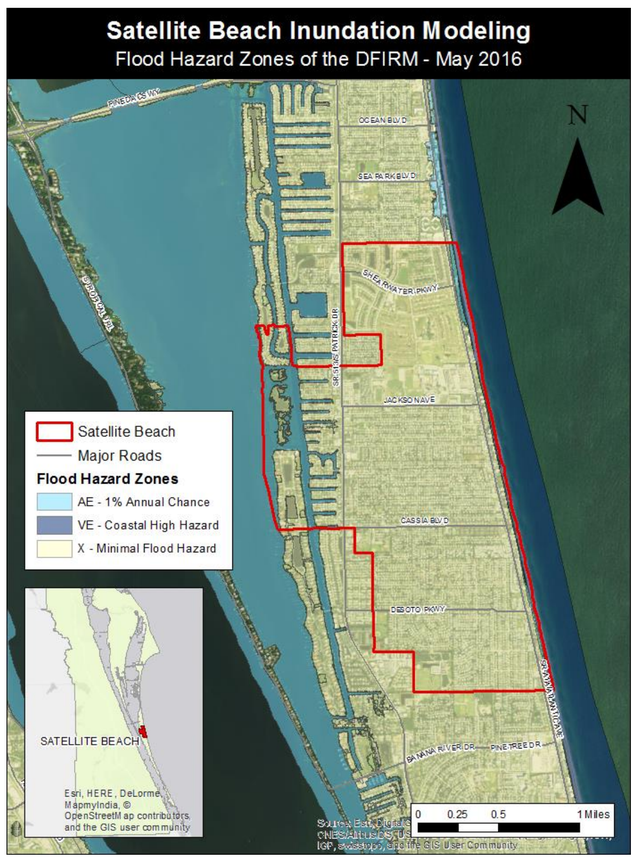
Study Area

Satellite Beach is a small city in Brevard County, about 30 miles south of Cape Canaveral. Satellite Beach is situated on a low-lying barrier island, with the Atlantic Ocean to the east and the Indian River Lagoon to the west. The city has an estimated population of 10,832 and has a land area of 2.92 square miles (https://www.census.gov/quickfacts/fact/table/satellitebeachcityflorida/PST045216). To the north of Satellite Beach lies Patrick Air Force Base and to the south lies the City of Indian Harbour Beach. Virtually all of the barrier island is built-out, leaving Satellite Beach no easy avenues for retreat from the impacts of sea level rise and increased coastal flooding. As a result, it is crucial for Satellite Beach to begin planning now for the long-term impacts of sea level rise on their community.

Results

The results of selected model runs can be seen in the maps displayed to the left. The model predicts severe flooding across the barrier island with the greatest flood depths being seen on the lagoon (western) side. Though the Atlantic side is more exposed to wave action, it is higher in elevation so sees comparatively less flooding.

Comparing the sea level rise scenarios, the 2040 intermediate and 2040 high scenarios show the difference between about half a foot and a whole foot of sea level rise on flooding. The overall area flooded changes little, with some spots that were not inundated by a 100-year storm with half a foot of sea level rise being filled in the whole foot scenario. Also, flood depth in flooded areas does not change dramatically. However, one can see that a 100-year storm with almost three feet of sea level rise (2070 high) inundates more than 75% of the land area of Satellite Beach and half of that inundated area has a water depth of at least four feet.



Conclusion & Limitations

The impact of the modeled flooding on Satellite Beach is dramatic. Large portions of the city are likely to be inundated during a severe storm. Adding in future sea level rise makes the potential flooding even worse. Local officials and stakeholders should use these outputs to consider where to focus future infrastructure additions or which essential facilities may need to be improved. Though the models may not perfectly describe how the city will be impacted by a coastal flooding event, providing officials with a better idea of what can occur in a major storm will improve emergency response and future planning efforts.

It is interesting to compare these outputs to the Flood Insurance Rate map produced by FEMA. The map of the flood zones can be seen above. There are large discrepancies between the 100-year floodplain developed by FEMA and modeled by Hazus. As gleaned from documentation, some model differences partially describe the variation, but the dramatic divergence in the floodplain is curious.

Finally, though the scenarios generated by the various model runs provide useful information for local officials, there are some inherent challenges with them. The Hazus model is a bit of a black box. It isn't easy to glean from the documentation the exact methodology used to generate flood depths. Other than the DEM and flood parameters, little information is needed to successfully run the model. This makes the tool useful for planners and officials who do not necessarily need extremely precise or highly customized model results.

Modeling Coastal Flooding and Community Impacts

Implementing Resiliency Through Data-Driven Analyses

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