

Coastal Resilience Index

Synthesizing Hazard Vulnerability

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Motivations

Population Living on Coast

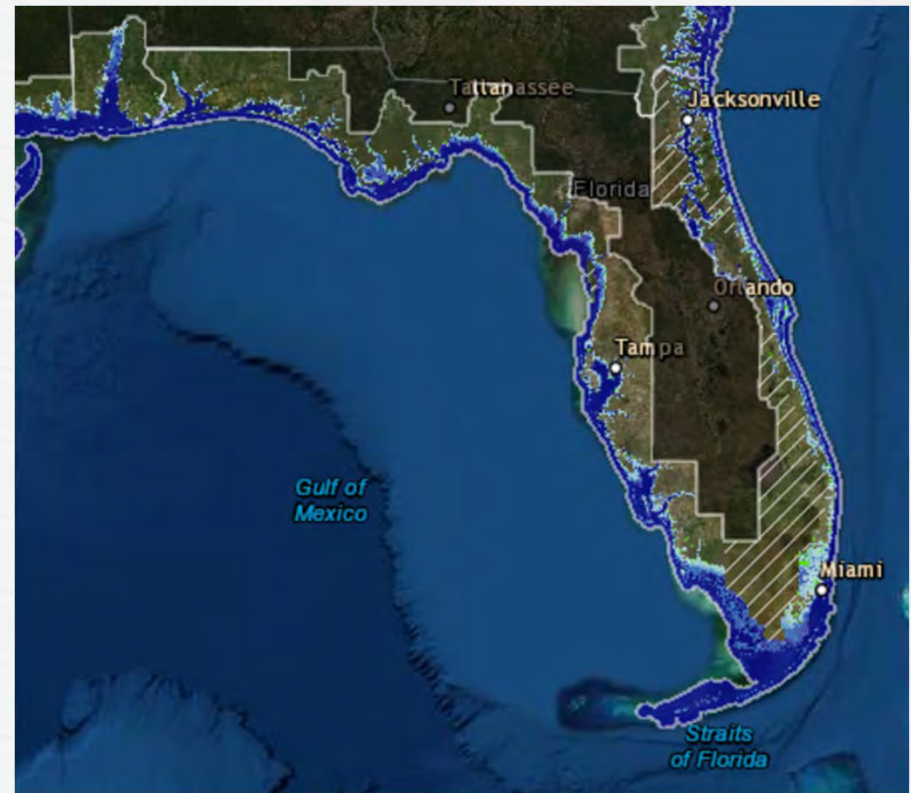
United States: 40%

Florida: 75%

Rate of Sea Level Rise

2011-2015: Sea Level Rise in Southeast Florida was >3 times the global average

- Valle-Levinson, A., Dutton, A., & Martin, J. B. (2017).
Geophysical Research Letters.



Inundation with a 6ft SLR

source: NOAA

Motivations

Tidal Flooding: Temporary inundation of low lying areas during periods of exceptionally high tides

Florida: Estimated \$5.4B in property value loss on account of tidal flooding

- First Street Foundation

Florida: Estimated \$76B in costs for sea level rise adaptation by 2040

- Center for Climate Integrity



Getting the Risk Wrong Costs Money

Defining Resilience

Vulnerability (V): function of risk factors that define loss potential at each location, i .

$$V_i = f(\text{risk factors}_i)$$

$$\text{Resilience} = \frac{1}{V}$$

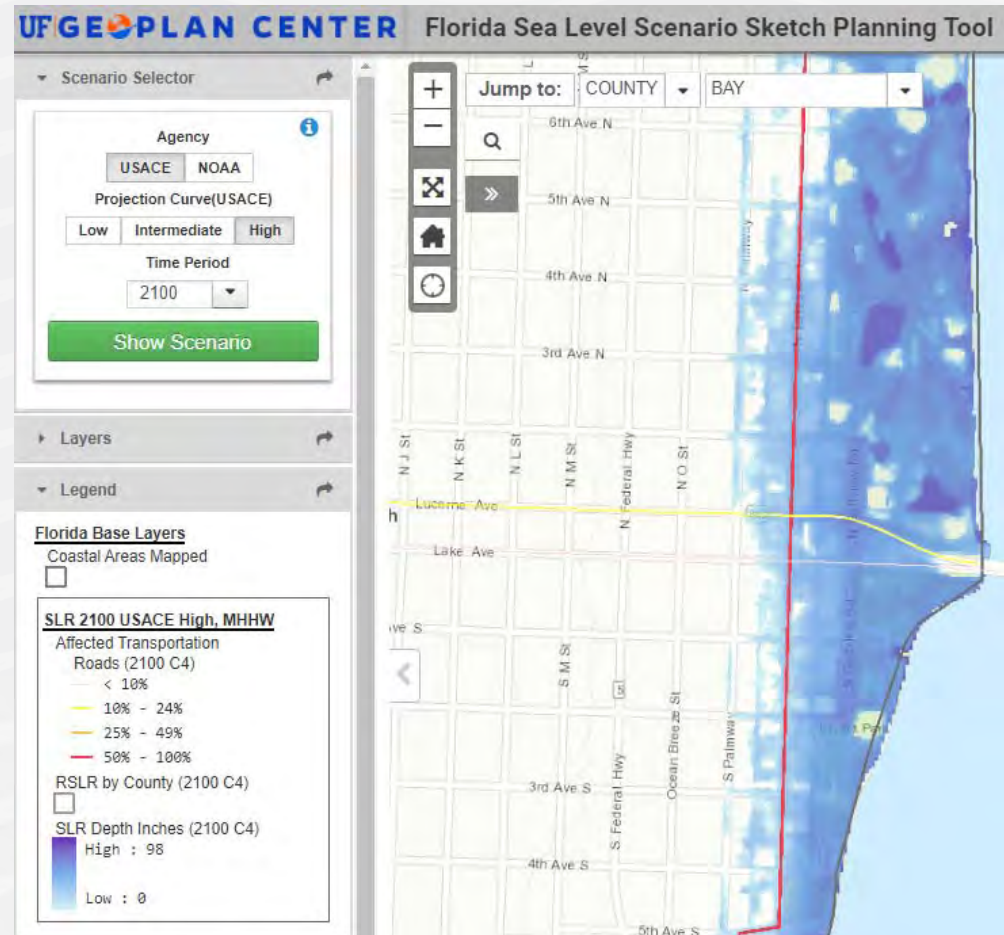
Existing Mitigation Analysis Tools

Sea Level Scenario Sketch Planning Tool (UF/FDOT)

Identifies and displays areas of potential inundation by sea level rise

Criteria

- Sea Level Rise Flood Projections (USACE and NOAA)
- FDOT Roads layers
- Digital Elevation Models
- Google Base Maps



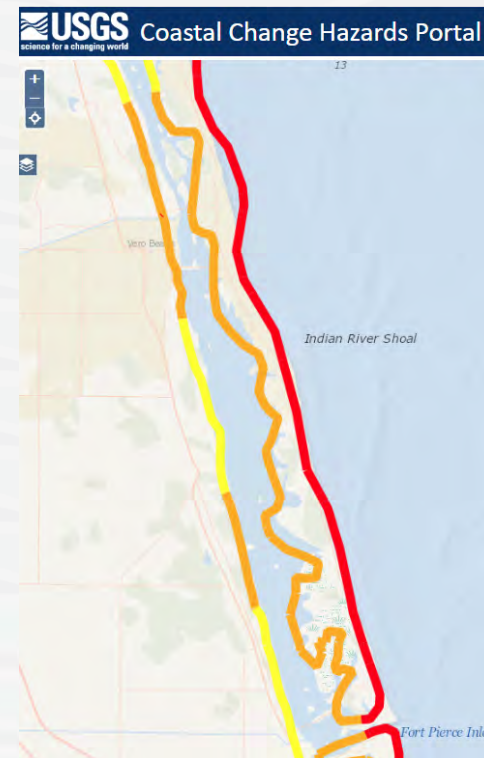
Existing Mitigation Analysis Tools

Coastal Vulnerability Index (USGS)

Indicates where physical changes are likely to occur due to Sea Level Rise

Criteria

- Tidal Range
- Wave Height
- Coastal Slope
- Shoreline Change



Coastal Vulnerability Index

- Low
- Moderate
- High
- Very High

Existing Mitigation Analysis Tools

HAZUS (FEMA)

Calculates estimated loss due to physical damage from hazards

Spatially analyzes:

- Buildings
- Critical Facilities
- Infrastructure
- Debris Generation

Computes:

- Direct Loss
- Cost of Repair/Replace
- Income Loss
- Agricultural loss

The screenshot displays the HAZUS-MH software interface. At the top, the title bar reads "HAZUS-MH: Flood - KaerntenFlood (test)". Below the menu bar, a toolbar contains various icons. On the left, a "Layers" panel lists several layers, including "UserDefin", "Boundary", "DGRiv", "Census Bl", "Census Tr", and "Study Reg". The main window features the FEMA logo and a prompt: "Please select one of the following". Below this prompt are several buttons: "Import into CDMS Repository from File", "Import into CDMS Repository from HAZUS-MH Study Region", "Building-Specific Data", and "Query/Export Statewide Datasets". A "Current State" dropdown menu is set to "California". At the bottom, it shows "Input File Name: CDMS_GLAN_FIRE.x" and "Data Import Type: Site Specific".

Overlaid on the main window is a dialog box titled "Direct Economic Loss (in thousands of dollars)". It has tabs for "By Specific Occupancy", "By General Occupancy", and "Total". The "By Specific Building Type" tab is selected. The table type is "W1". The table below shows the following data:

Table	Non-Structural Damage (thous. \$)	Building Damage (thous. \$)
1	\$7,093.30	\$8.60
2	\$3,273.21	\$3.83
3	\$13,977.37	\$16.82
4	\$15,881.41	\$19.97
5	\$11,300.57	\$13.32
6	\$22,383.05	\$27.23
7	\$19,010.16	\$23.27
8	\$12,781.09	\$14.93
9	\$20,551.32	\$23.56
10	\$14,024.34	\$16.80
11	\$11,291.41	\$13.15
12	\$18,362.83	\$20.69
13	\$16,940.25	\$19.62
14	\$7,296.44	\$9.00

Existing Mitigation Analysis Tools: Unsatisfied Needs

Ease of use

Holism

Florida-specific

Sea level rise

Climate change

Proposed Tool *Methodology:* *Multi-Linear Regression*

Objective: Establish statistical relationships to formulate vulnerability, defined as economic losses, based on past flooding events.

$$V = \beta_0 + \beta_1 P + \beta_2 F + \beta_3 C$$

V = Vulnerability [\$]

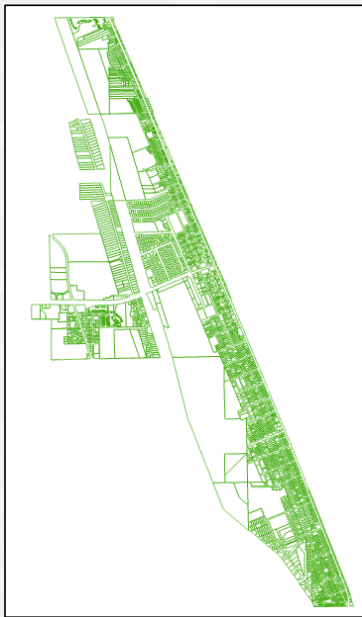
P = Parcel Value [\$]

F = Flood Zones [ft]

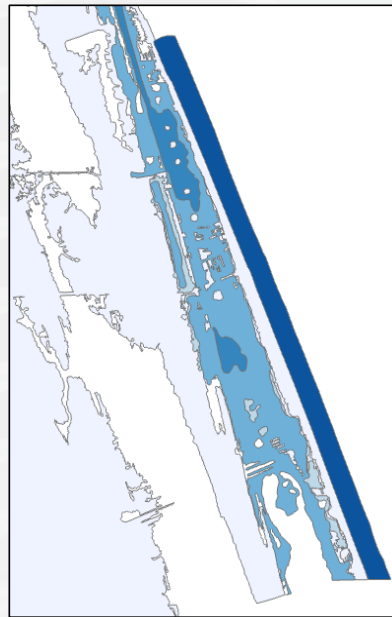
C = Census Count [.]

Conceptual Overview of a New Tool: *Inputs*

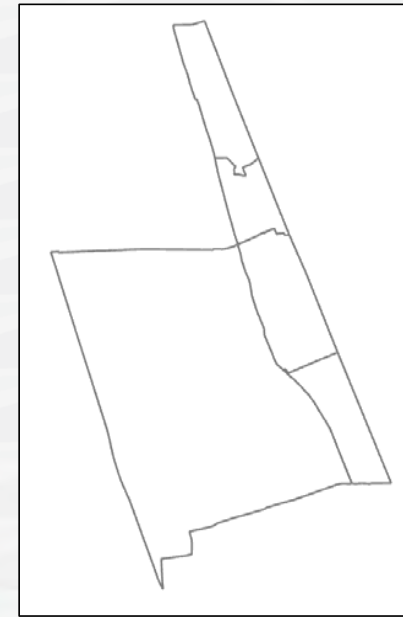
Parcels



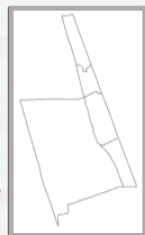
Flood Zones



Census Blocks



Conceptual Overview of a New Tool: *Interface*



Geoprocessing ▾ 🔍 ✕

← Conceptual Tool ☰

Parameters | Environments ?

Input Geodatabase 📁

Parcels 📁

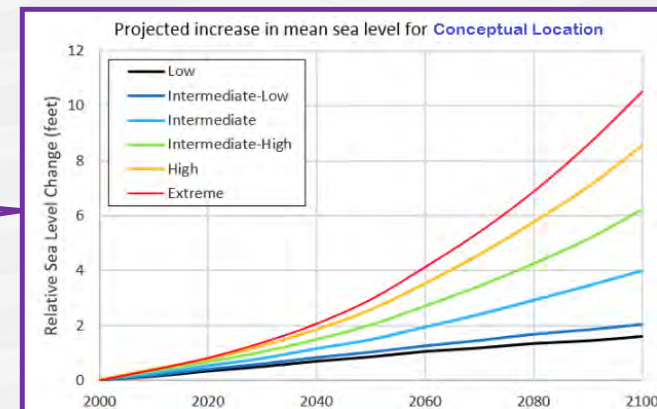
Flood Zones 📁

Census Blocks 📁

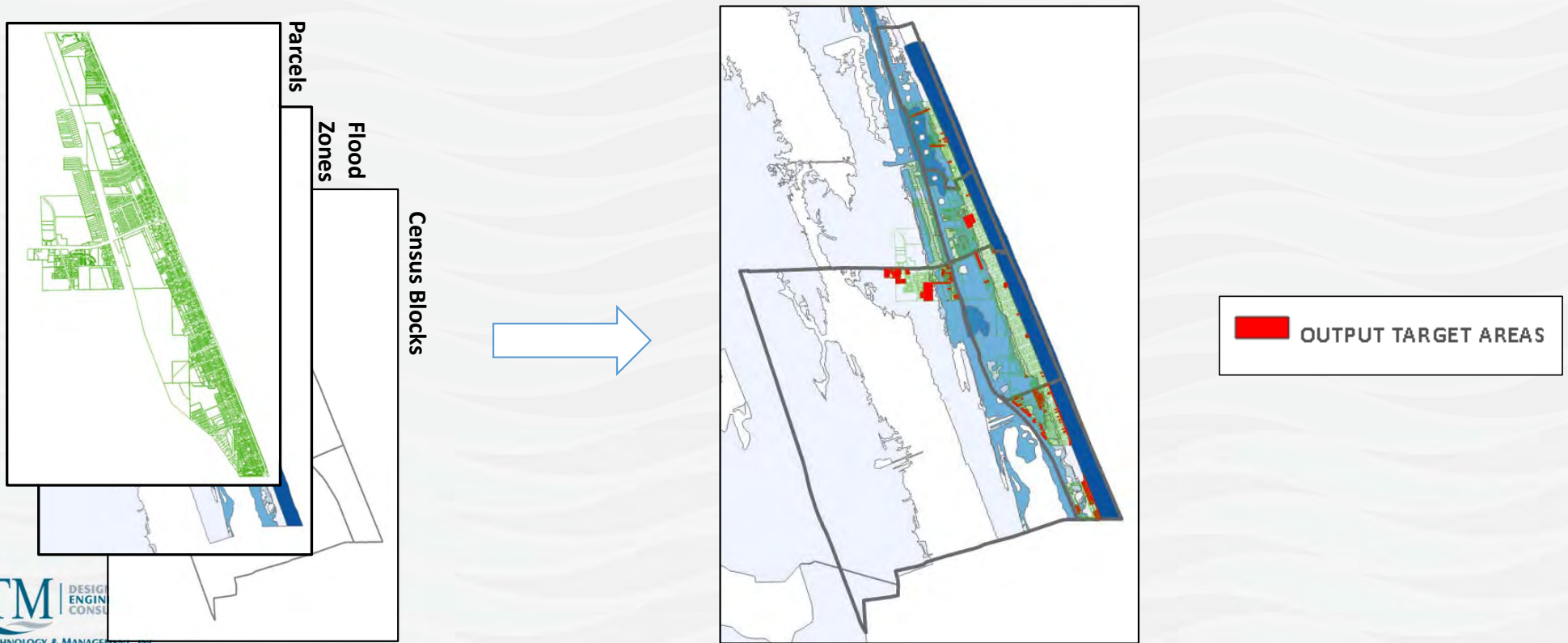
Model Year 📁

Scenario 📁

Run ▶



Conceptual Overview of a New Tool: *Output*



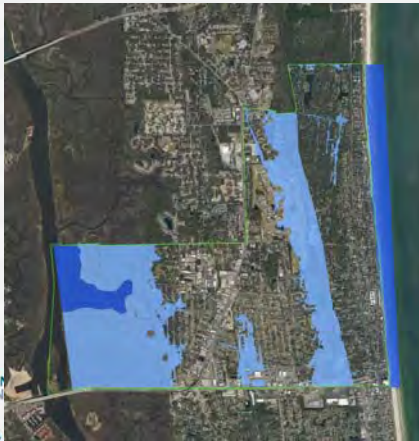
ATM's Tool: Distinguishing Features

Florida-centered Modifications

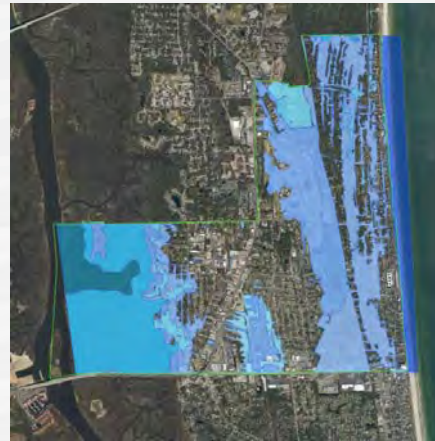
- Coastal/Hydrodynamic Elements
- Insurance Factor

Sea Level Rise and Climate Change

2044 Flooding



2069 Flooding



2119 Flooding



ATM's Tool: Increased Storm Frequency & Severity



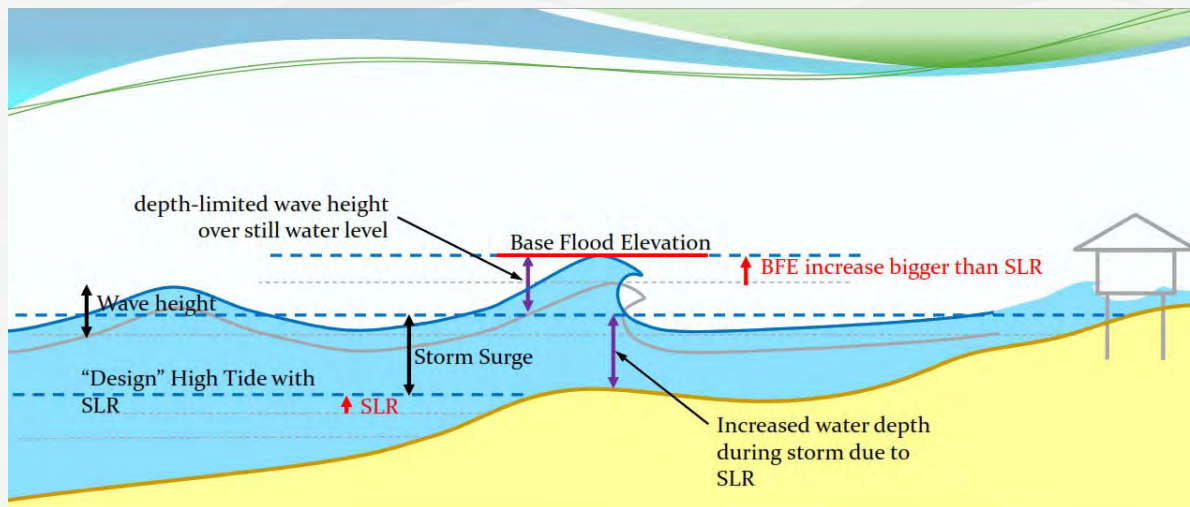
"The heaviest rainfall events have become heavier and more frequent"

"Tropical rainfall rates and intensities will likely increase in the future due to anthropogenic warming and accompanying increase in atmospheric moisture content"

Incorporating into tool:

- Gradually increase impact factor of flooding on a temporal scale

ATM's Tool: Wave Height Adjustments



- FEMA flood maps do not account for Sea Level Rise
- Storm Surge and Wave Height for 100-yr storm may change if events are more intense or frequent

Incorporating into tool:

- Increase impact factor of VE Zones

ATM's Tool: Insurance Uncertainty



“a repeat of a Hurricane Andrew-sized loss today (\$50 billion to \$60 billion) would result in more insurer insolvencies than occurred in 1992.”

“various vulnerabilities in the current Florida residential insurance market”

- Journal of Insurance Regulation (2018)

Incorporating into tool:

- Increase Parcel Value coefficient
- Increase impact factor of displaced household/residents

Conclusions

How this Tool Helps FSA Members

- GIS-based
- Florida-centric
- Easy data acquisition
- Target identification
without extensive
resource outlay