



#DESIGNSAVES

Miami 2040: The Climate Change Context

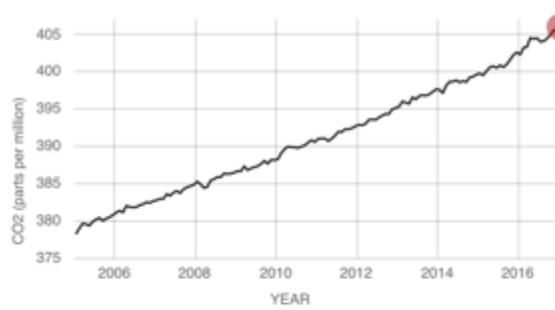
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Climate change *is real and happening now*

Carbon Dioxide

DIRECT MEASUREMENTS: 2005-PRESENT

Data source: Monthly measurements (average seasonal cycle removed). Credit: NOAA



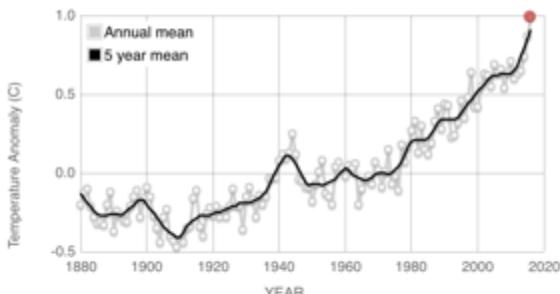
Get Data: [FTP](#) | Snapshot: [PNG](#)

Carbon dioxide (CO₂) is an important heat-trapping (greenhouse) gas, which is released through human activities such as deforestation and burning fossil fuels, as well as natural processes

Global Temperature

GLOBAL LAND-OCEAN TEMPERATURE INDEX

Data source: NASA's Goddard Institute for Space Studies (GISS). Credit: NASA/GISS



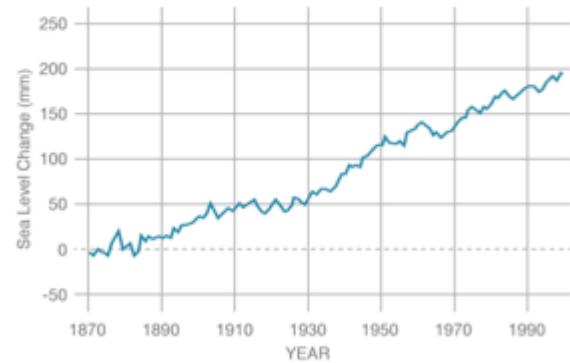
Get Data: [HTTP](#) | Snapshot: [PNG](#)

This graph illustrates the change in global surface temperature relative to 1951-1980 average temperatures. The 10 warmest years in the 136-year record all have occurred since 2000, with the exception of 1998. The year 2016 ranks as the warmest on record.

Sea Level

GROUND DATA: 1870-2000

Data source: Coastal tide gauge records. Credit: CSIRO



Sea level rise is caused primarily by two factors related to global warming: the added water from melting land ice and the expansion

Source: <http://climate.nasa.gov>



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Avoiding the Unmanageable – “Mitigation”

&

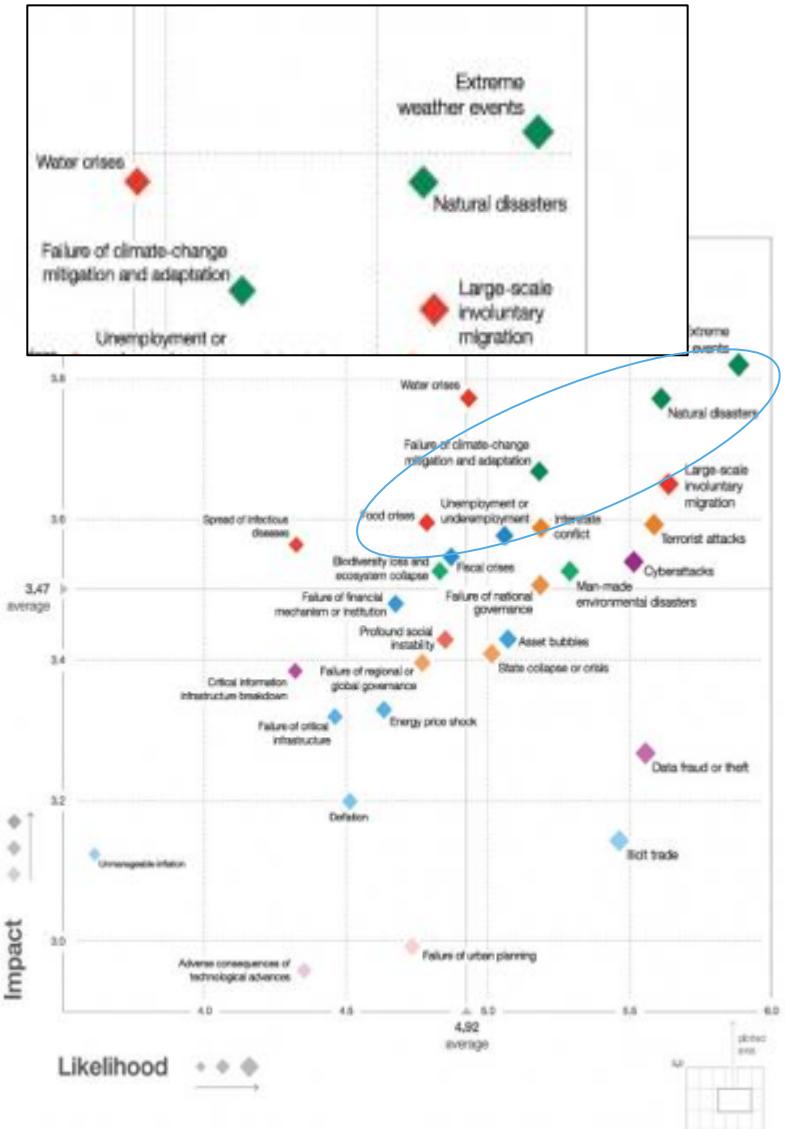
Managing the Unavoidable – “Adaptation”

Managing the Unavoidable – “Adaptation”

Extreme weather and natural hazards are recognized as **leading global threats**

Climate change **loads the dice and raises the stakes**

- Extreme temperature
- Drought
- **Extreme precipitation/flood**
- **Sea level rise**
- **Hurricane behavior**
- ...



Hurricane Andrew, 1992



“Over 25,000 houses were destroyed in Miami-Dade County alone, and nearly 100,000 more were severely damaged. 65 people were killed and the damage total across the affected regions exceeded \$26 billion (1992 USD).”



Source: https://en.wikipedia.org/wiki/Hurricane_Andrew

Climate change has an impact *now*



“Coastal mortgages are growing into as big a bubble as the housing market of 2007,” said Philip Stoddard, the mayor of South Miami. But this time, he said, there will not be a rebound because the waters will not recede and properties will eventually lose all of their value.





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Sea Level Rise

Hurricane

Extreme Precipitation

Sea Level Rise + Hurricane

Sea Level Rise + Extreme Precipitation



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“In Miami-Dade County, Florida, for example, a uniform 90 cm (~3 ft) sea-level rise would permanently inundate the residences of about 5% of the county's population, about the same fraction currently threatened by the storm tide of a 1-in-100 year flood event [Tebaldi et al., 2012]. A 1-in-100 year flood on top of such a sea-level rise would, assuming geographically uniform flooding, expose an additional 35% of the population (Climate Central, Surging Seas, 2013, retrieved from SurgingSeas.org, updated November 2013).” –

Kopp, Robert E., et al. "Probabilistic 21st and 22nd century sea-level projections at a global network of tide-gauge sites." *Earth's future* 2.8 (2014): 383-406.

Sea Level Rise + Extreme Precipitation/Hurricane



Sea Level Rise and Coastal Flooding Impacts

Try the New Beta!

Sea Level Rise Confidence Marsh
Vulnerability Flood Frequency

Sea Level Rise

 Current MHHW

Legend

- Water Depth
- Low-lying Areas
- Area Not Mapped
- Visualization Location
- Leveed Areas

Overview

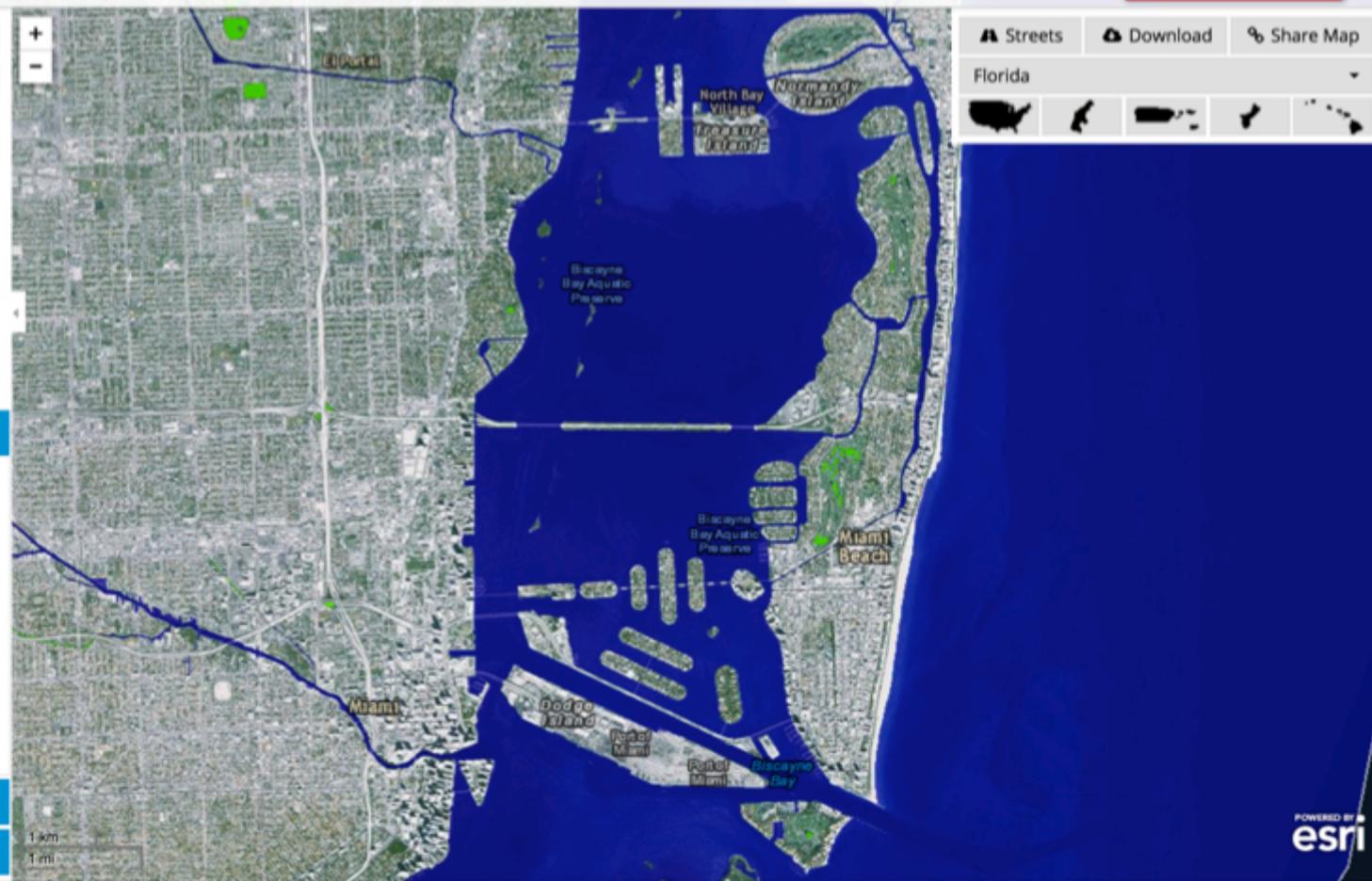
Use the slider bar above to see how various levels of sea level rise will impact this area.

Levels represent inundation at high tide. Areas that are hydrologically connected are shown in shades of blue (darker blue = greater depth).

Low-lying areas, displayed in green, are hydrologically "unconnected" areas that may flood. They are determined solely by how well the elevation data captures the area's hydraulics. A more detailed analysis of these areas is required to determine the susceptibility to flooding.

Understanding The Map

Additional Information



“Sea-level rise at Key West, Florida, is closer to the global mean, with a likely range in RCP 8.5 by 2100 of **0.6-1.1 m (~2-3.3 ft)**” Kopp et al. 2014

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Sea Level Rise and Coastal Flooding Impacts

[Try the New Beta!](#)[Sea Level Rise](#) | [Confidence](#) | [Marsh](#)[Vulnerability](#) | [Flood Frequency](#)

Flood Frequency

Legend

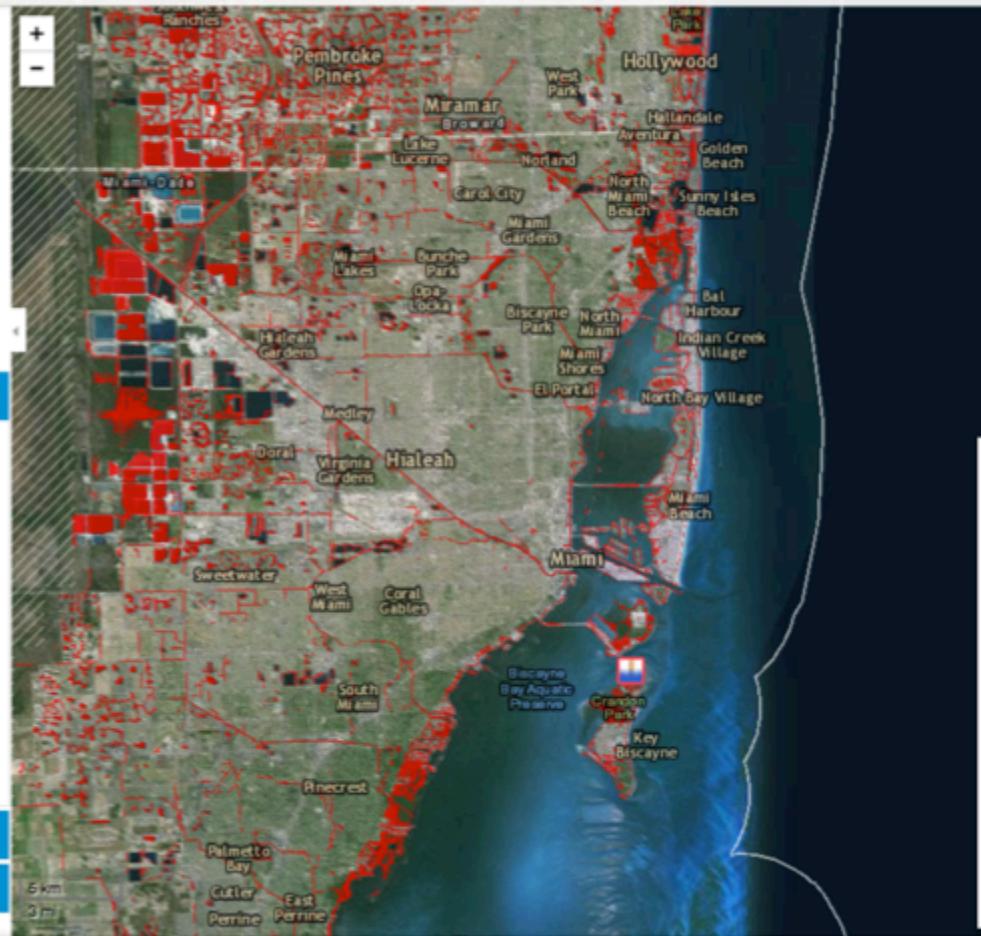
- Shallow Coastal Flooding Areas
- Area Not Mapped
- Tide Gauges
- Leveed Areas

Overview

Flooding will become more frequent as sea level rises. In a sense, today's flood will become tomorrow's high tide, as sea level rise will cause flooding to occur more frequently and last for longer durations of time.

The red layer in the map represents areas currently subject to shallow coastal flooding.

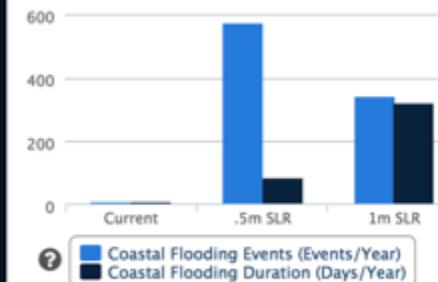
Click on a NOAA tide station in the map to see information on the current frequency of coastal flood events and durations as compared to hypothetical half-meter and one-meter sea level rise scenarios.

Understanding The Map**Additional Information**

Streets Download Share Map
Florida

Coastal Flood Frequency

Virginia Key Tide Gauge #8723214
Flooding begins at 3.5 ft MLLW



Real-Time Tidal Data | Sea Level Trends

[Contact Us](#) | [Privacy Policy](#) | [Link Disclaimer](#) | [USA.gov](#)

SLR + Hurricane/Flood Scenarios

Hurricane Andrew → ~17 ft storm surge in Miami

Source: <http://www.huricanescience.org/history/storms/1990s/andrew/>



Sea Level Rise and Coastal Flooding Impacts

[Try the New Beta!](#)[Sea Level Rise](#) [Confidence](#) [Marsh](#)[Vulnerability](#) [Flood Frequency](#)

Socioeconomic Vulnerability

[Current MHHW](#)

Legend

Water Depth

- Unconnected Areas
- Area Not Mapped
- Leveed Areas

Social Vulnerability

- High
- Med
- Low

Social

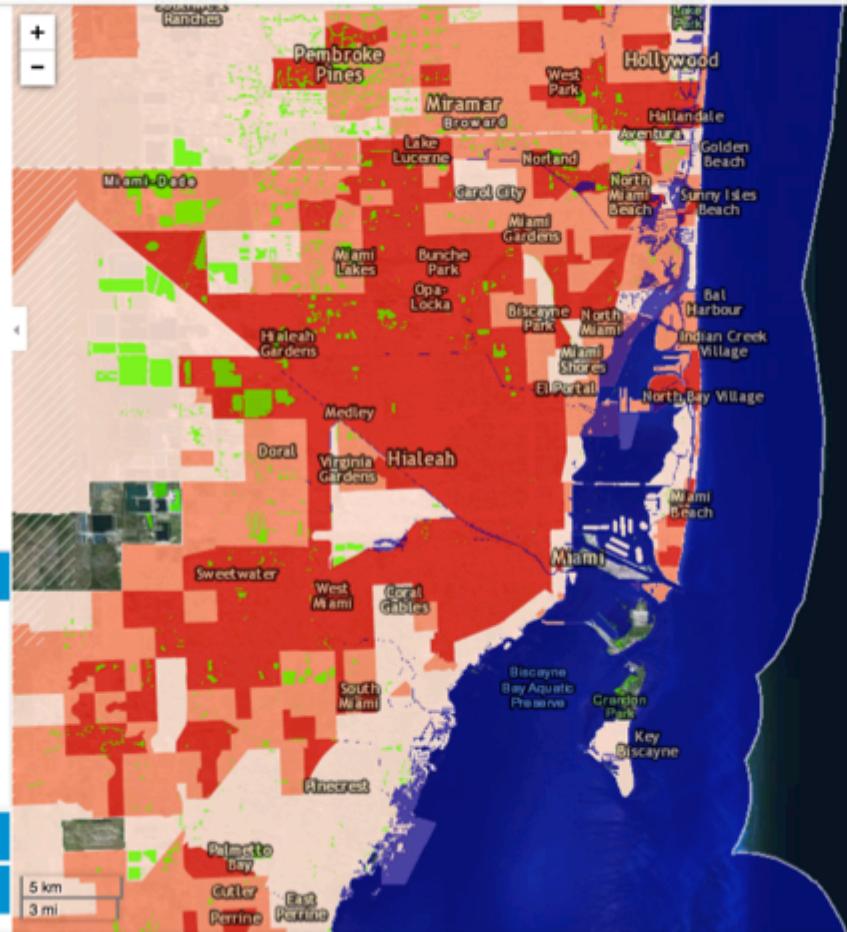
Overview

By overlaying social and economic data on a map that depicts sea level rise, a community can see the potential impact that sea level rise can have on vulnerable people and businesses.

The Social Vulnerability Index, which shows areas of high human vulnerability to hazards, is based on population attributes (e.g., age and poverty) and

Understanding The Map

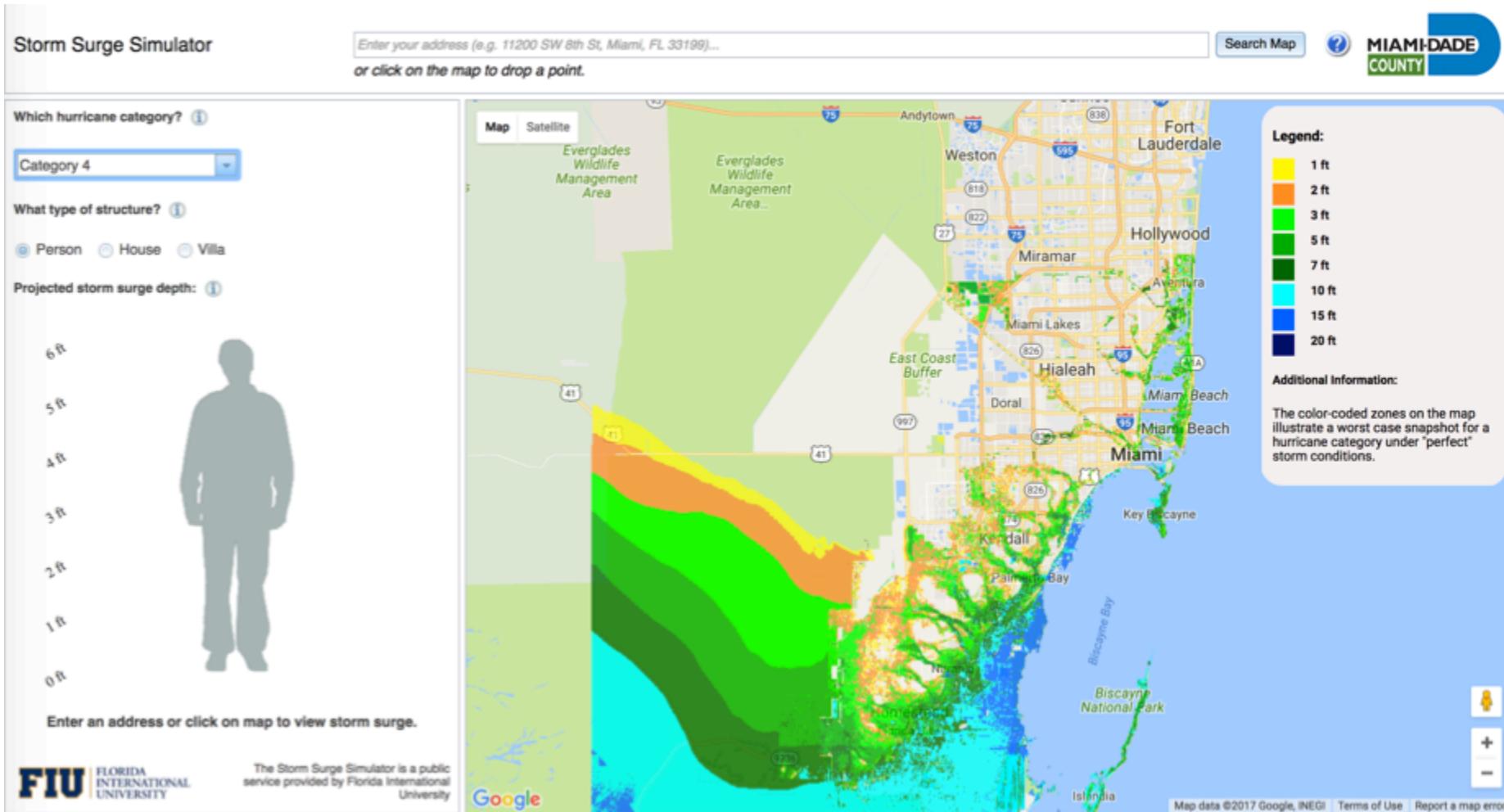
Additional Information

[Streets](#)[Download](#)[Share Map](#)

Florida

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Vulnerability



Storm Surge from Hurricanes



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Designing while keeping in mind...

- Uncertainty - designing for the “worst plausible case” (robustness of idea >> precision of data behind it in our case)
- Cost-risk tradeoffs
- Vulnerable populations
- Incentives

Resilience/Adaptation Examples

More pumps and raised roads in Miami Beach

The city is about to spend \$100 million over the next two years to raise roads, install stormwater pumps and upgrade sewer connections in the La Gorce and Lakeview neighborhoods in Middle Beach.



Source: <http://www.miamiherald.com/news/local/community/miami-dade/miami-beach/article129284119.html>

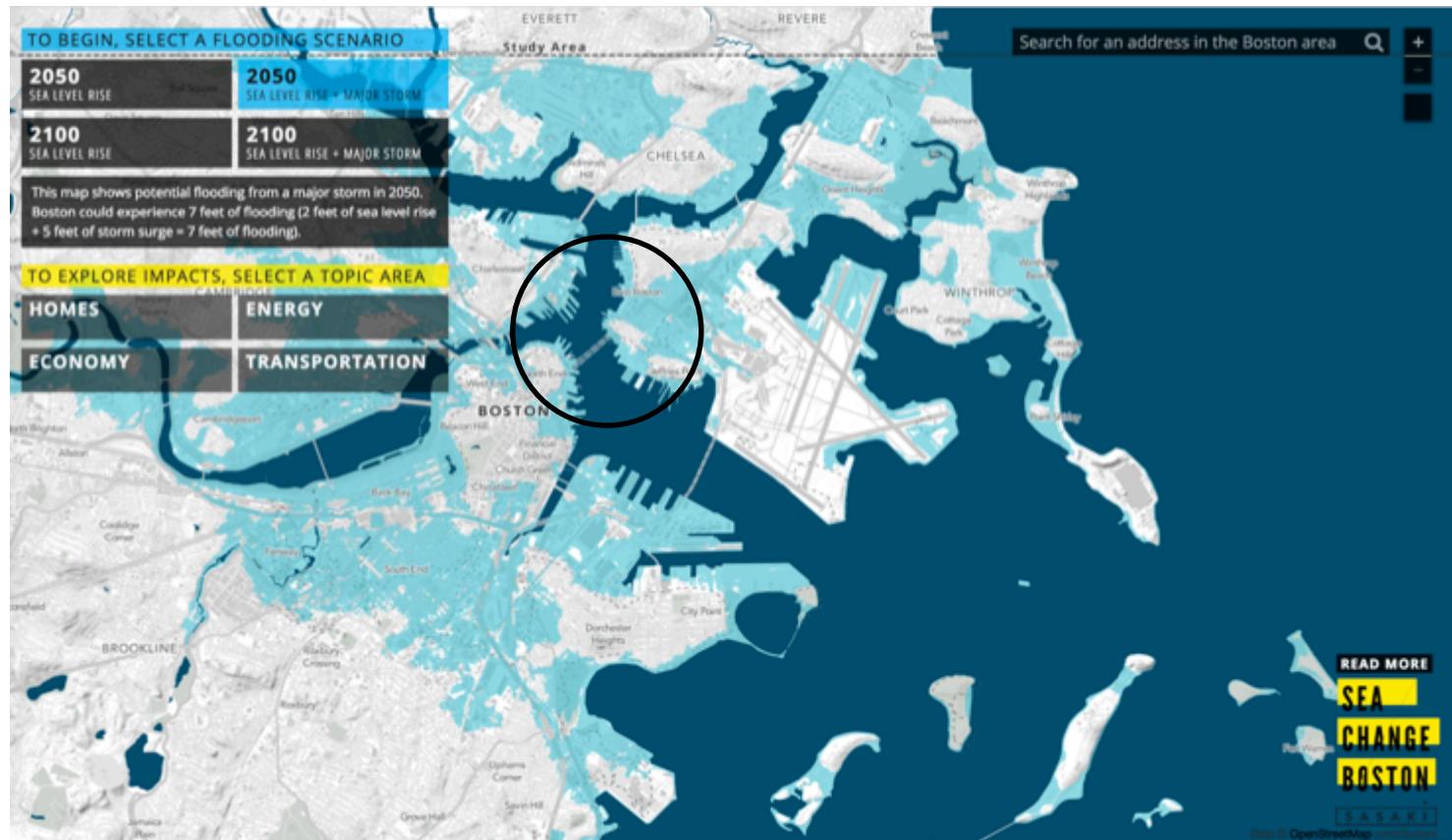
Resilience/Adaptation Examples



Source: A shoreline retrofit designed by a team led by the architecture firm OMA for Hoboken, New Jersey, integrating barriers to protect against storm surges while providing new recreational opportunities. Illustration: Rebuild by Design.

http://www.100resilientcities.org/blog/entry/how-a-design-competition-changed-the-us-approach-to-disaster-response#/__1

Resilience/Adaptation Examples



Utilizing assets off-season



Resilience/Adaptation Examples



Resilience/Adaptation Examples?

AIR TREKKERS
JUMPING STILTS

404-509-1817

9am-5pm PST

BUY NOW
CLEARANCE
PARTS
AFFILIATES
LATEST VIDEOS
COOL NEW PICS
RESEARCH STUDY

TESTIMONIALS
FAQS
ABOUT US
CONTACT US

**WE SHIP
TO OVER
200 COUNTRIES**

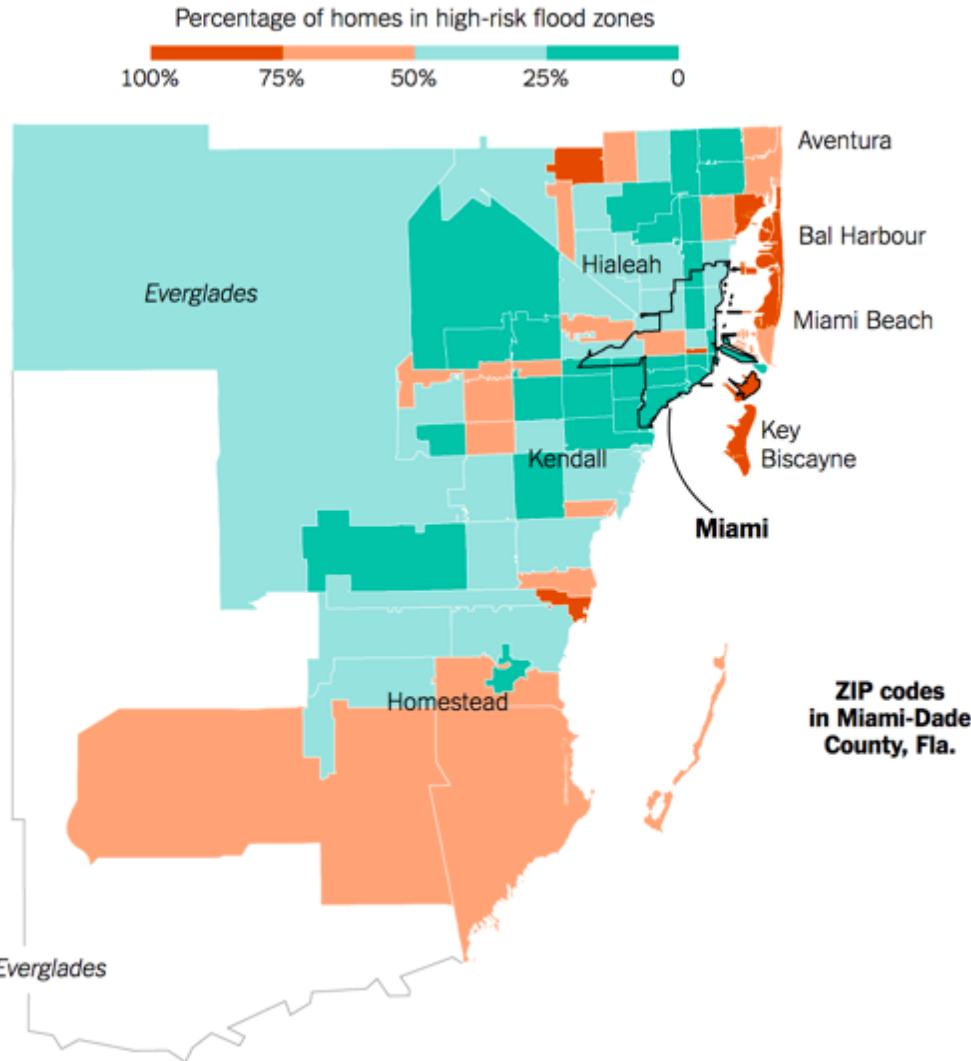
GET Extreme Air

jump up to 9 feet

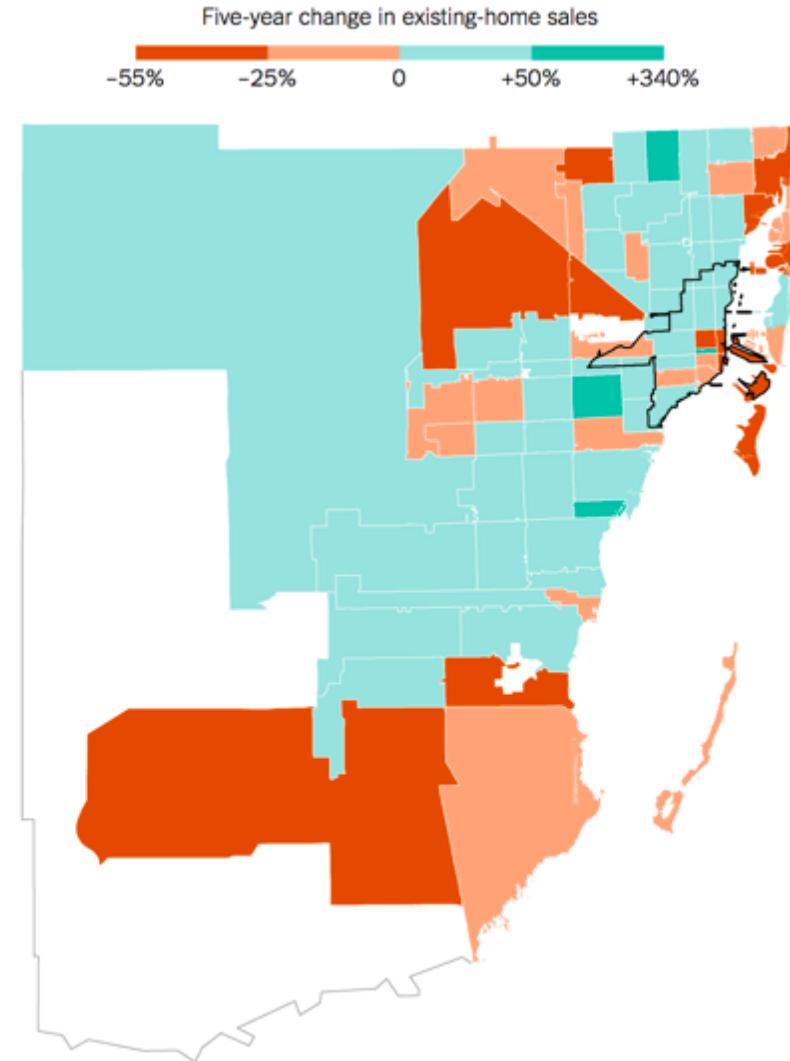
**ALL MODELS
AND SIZES
IN STOCK
READY TO
SHIP**

Entrepreneurial Examples

Many areas around Miami that flood the most ...

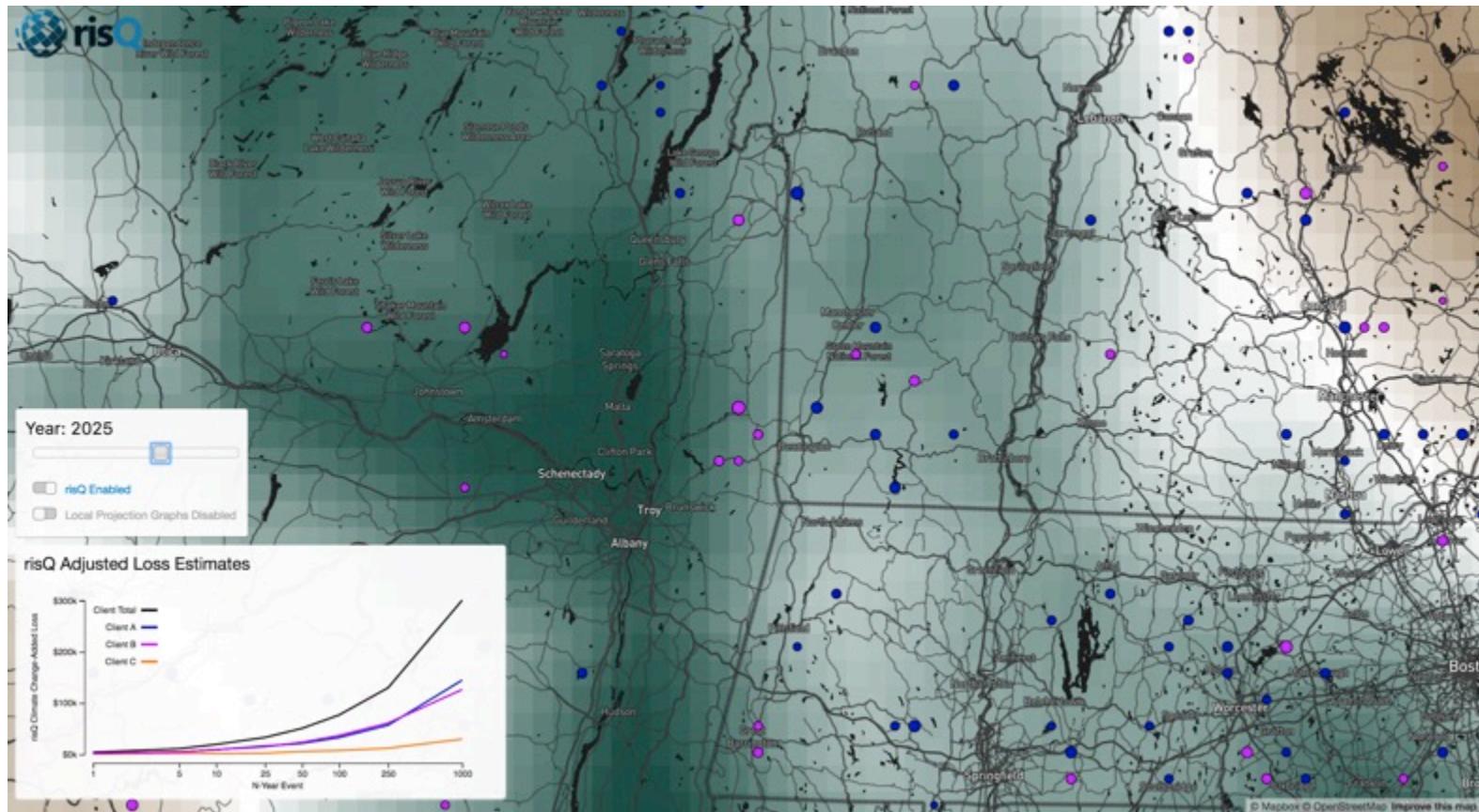


... have had slower real estate sales in the last five years.



Entrepreneurial Examples

Quantifying incremental losses for insurance companies



Tools, Resources & Data

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<https://coast.noaa.gov/digitalcoast/tools/slris.html> --
Sea Level Rise Predictions

<http://www.100resilientcities.org> --
Ideas from other cities

<https://climate.miami.edu/> -
reading material, extensive climate change
impacts specifically for Miami

<http://earl.cis.fiu.edu/gic/> --
storm surge from hurricanes (*current sea level*)

<http://gisweb.miamidade.gov/GISSelfServices/GeographicData/MDGeographicData.html> --
Many layers of Miami GIS data