

Adaptation in a Sea of Uncertainty

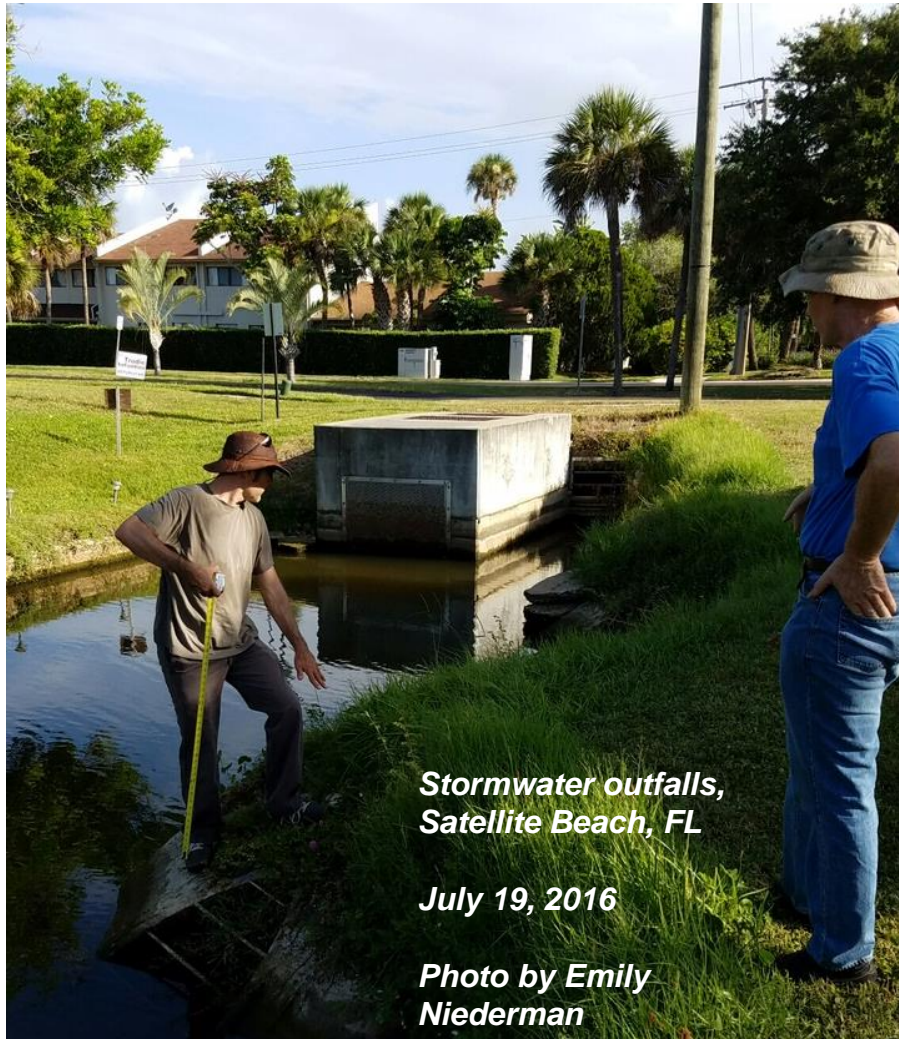
Sea Level Rise Planning at the Local Level

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Assistant Professor of Environmental Science
Stetson University

September 23, 2016

Sea-level Rise and Flooding:
Planning and Law for Local Governments
Jacksonville, FL



*Stormwater outfalls,
Satellite Beach, FL*

July 19, 2016

*Photo by Emily
Niederman*



My Past Few Years

Outreach > [Hyde County, NC Adaptation Plan](#)

Researcher Helps Florida Cities Adapt to Sea-Level Rise

August 11, 2016



Satellite Beach, FL Public Works

(From left to right) Emily Niederman, Jason Evans, Ph.D., and Adam Carr are mapping out the vulnerable areas of Satellite Beach, Fla. Photo by Rhiannon Boyer

community in the form of tailored resilience and adaptation plans.

the project.



UPDATES: Apply now for

Outreach

Coastal Hazards

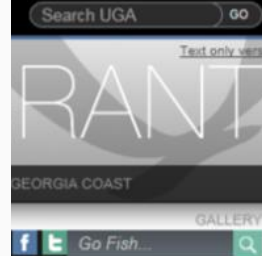
- > Climate Community of Practice
- > Crisis Response
- > Flood Insurance
- > Shoreline Change
- > Sea Level Rise
- > Tybee Island Sea Level Rise Plan
- > About the Project
- > Public Input and Outreach
- > Plan Outline
- > Planning Team
- > Media Coverage
- > Tybee Resources
- > St. Marys Flood Resiliency Plan
- > Hyde County, NC Adaptation Plan

Communicating Science
Healthy Coastal Ecosystem
Safe and Sustainable Seafood
Sustainable Development

Outreach



Research

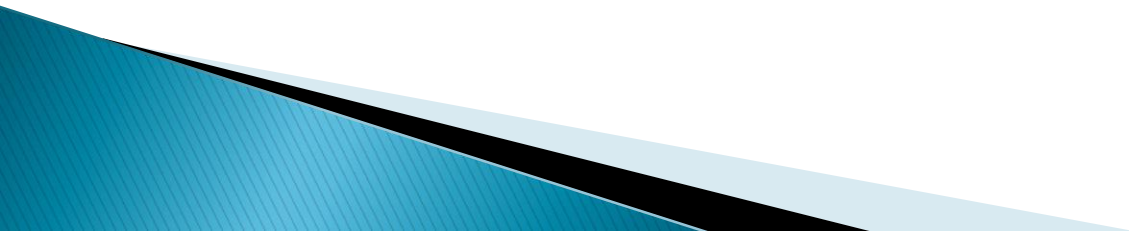


son Evans, Charles Hopkinson, Roger eaver and Mayor John Morrissey meet launch the St. Marys Flood Resiliency nning project.

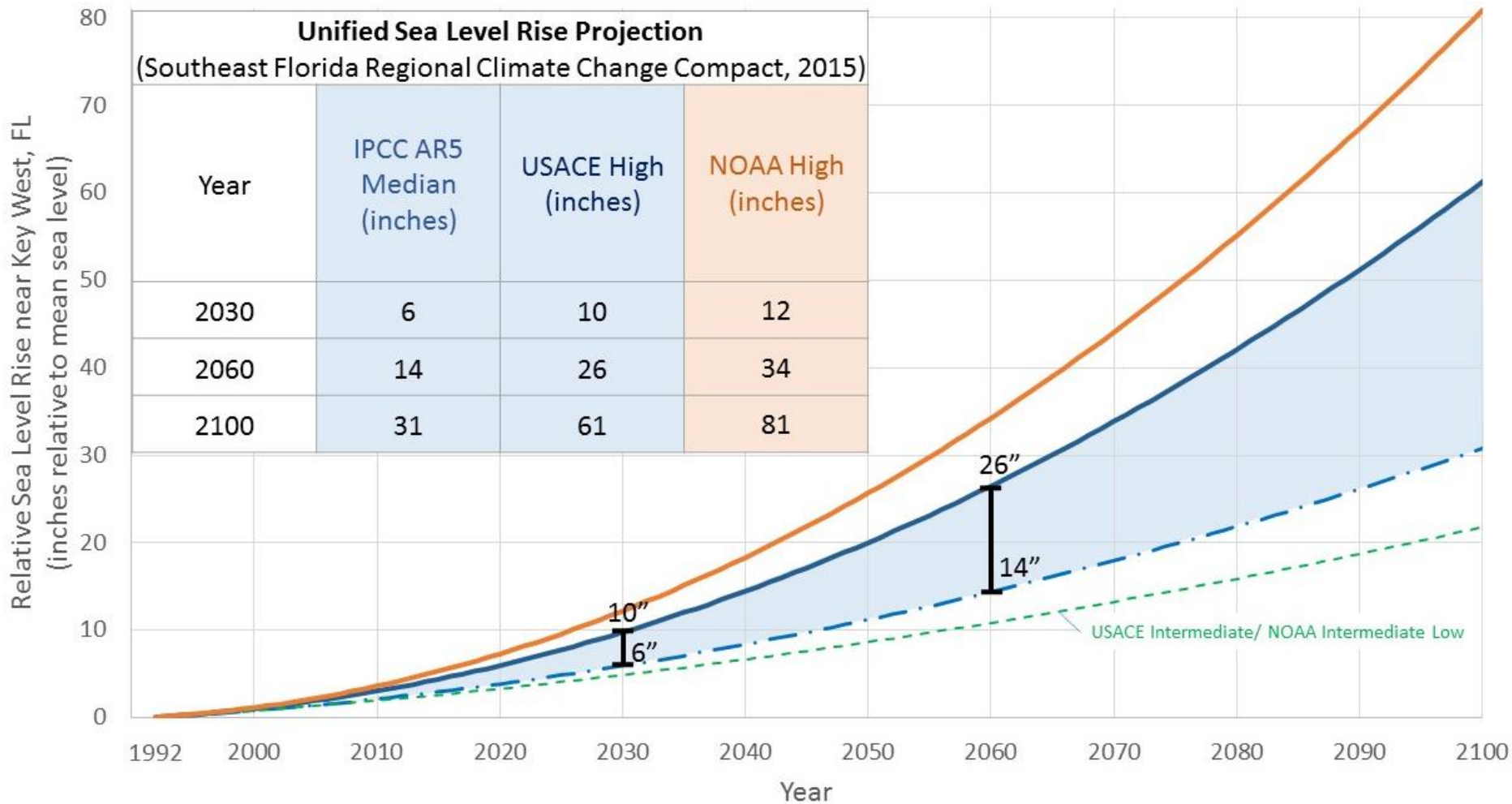
established in 1787, t. Marys is a historic ity that is vulnerable o anticipated coastal hanges, such as icrosofted coastal ooding, rising seas nd intensified storm urges.

Assertion #1

Climate change adaptation is one of the most complex and daunting challenges ever faced by human civilization.



Sea-level Rise is a big deal for FL...





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City, ST

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NOAA: 'Nuisance flooding' an increasing problem as coastal sea levels rise

Study looks at more than 60 years of coastal water level and local elevation data changes

July 28, 2014

Eight of the top 10 U.S. cities that have seen an increase in so-called "nuisance flooding"--which causes such public inconveniences as frequent road closures, overwhelmed storm drains and compromised infrastructure--are on the East Coast, according to a new NOAA technical report.

This nuisance flooding, caused by rising sea levels, has increased on all three U.S. coasts, between 300 and 925 percent since the 1960s.

The report, [Sea Level Rise and Nuisance Flood Frequency Changes around the United States](#),

also finds Annapolis and Baltimore, Maryland, lead the list with an increase in number of flood days of more than 920 percent since 1960. Port Isabel, Texas, along the Gulf coast, showed an increase of 547 percent, and nuisance flood days in San Francisco, California increased 364 percent.

"Achieving resilience requires understanding environmental threats and vulnerabilities to combat issues like sea level rise," says Holly Bamford, Ph.D., NOAA assistant administrator of the National Ocean Service. "The nuisance flood study provides the kind of actionable environmental intelligence that can guide coastal resilience efforts."

"As relative sea level increases, it no longer takes a strong storm or a hurricane to cause flooding," said William Sweet, Ph.D., oceanographer at NOAA's [Center for Operational Oceanographic Products and Services \(CO-OPS\)](#) and the report's lead author. "Flooding now occurs with high tides in many locations due to climate-related sea level rise, land subsidence and the loss of natural barriers. The effects of rising sea levels along most of the continental U.S. coastline are only going to become more noticeable and much more severe in the coming decades, probably more so than any other climate-change related factor."

The study was conducted by scientists at CO-OPS, who looked at data from 45 [NOAA water level gauges](#) with long data records around the country and compared that to reports of number of days of nuisance floods.



Annapolis, Maryland, pictured here in 2012, saw the greatest increase in nuisance flooding in a recent NOAA study. (Credit: With permission from Amy McGovern.)

Miami Beach



<http://s13.therealdeal.com/trd/m/up/2013/07/Miami-flooding-4-13-13.jpg.jpg>

*Tidal flooding on Tybee Island, GA
US Highway 80
October 27, 2015*

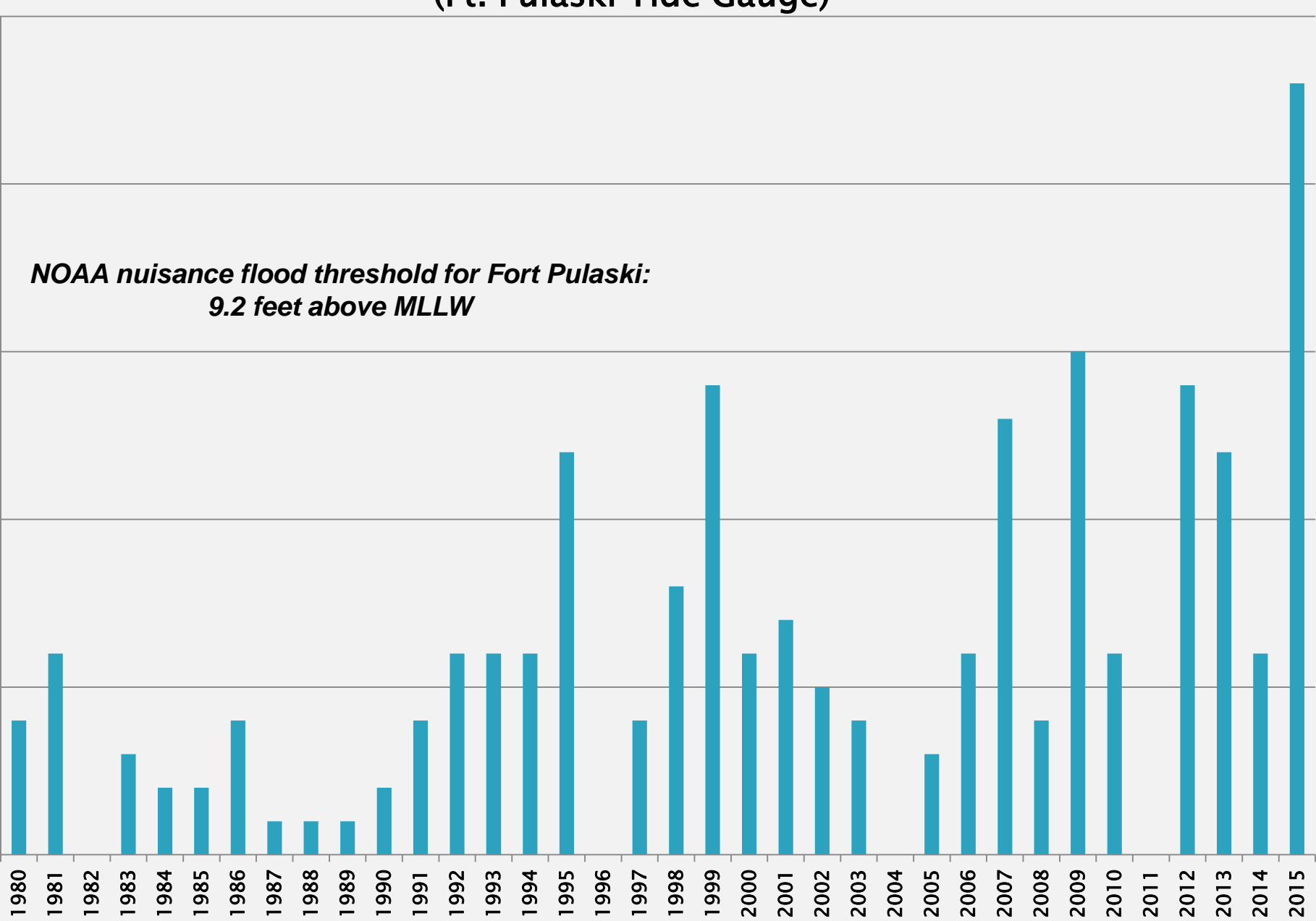


Third highest tide on record (since 1935) for this gauge

Only exceeded by tropical storm surges

Nuisance Floods by Year at Tybee Island, GA (Ft. Pulaski Tide Gauge)

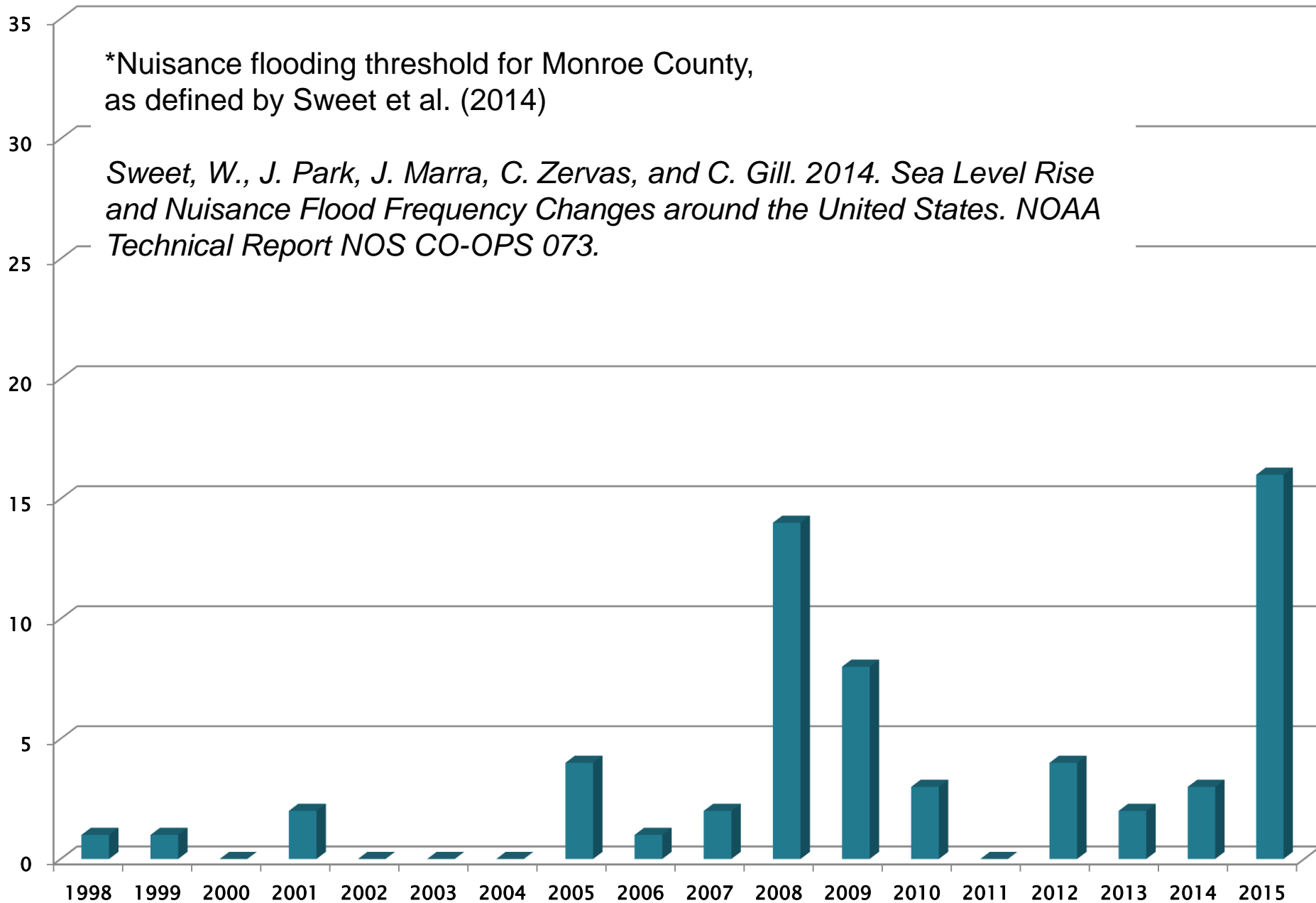
***NOAA nuisance flood threshold for Fort Pulaski:
9.2 feet above MLLW***



Nuisance Floods Per Year at Key West

*Nuisance flooding threshold for Monroe County,
as defined by Sweet et al. (2014)

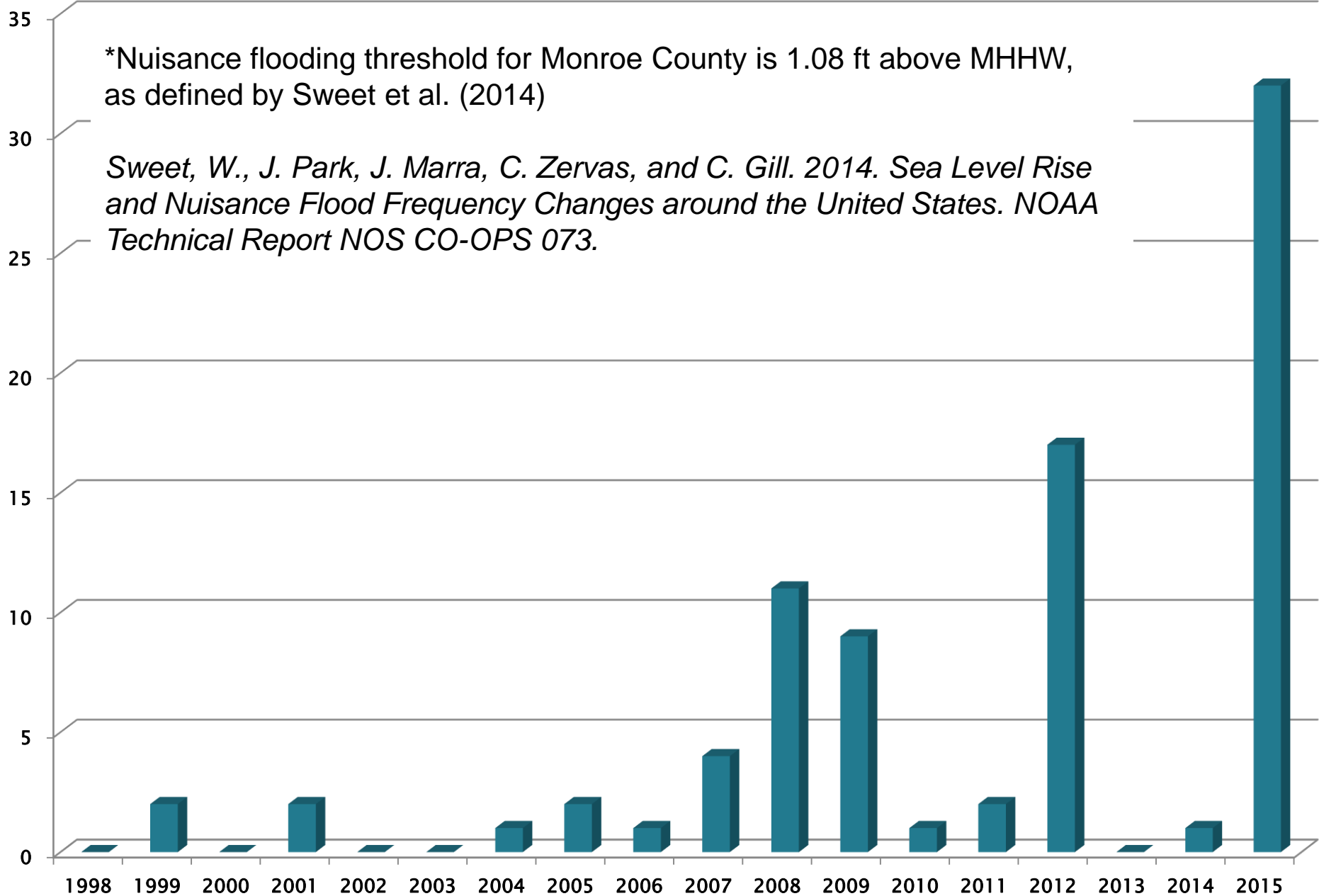
*Sweet, W., J. Park, J. Marra, C. Zervas, and C. Gill. 2014. Sea Level Rise
and Nuisance Flood Frequency Changes around the United States. NOAA
Technical Report NOS CO-OPS 073.*



Nuisance Floods Per Year at Vaca Key (Marathon, FL)

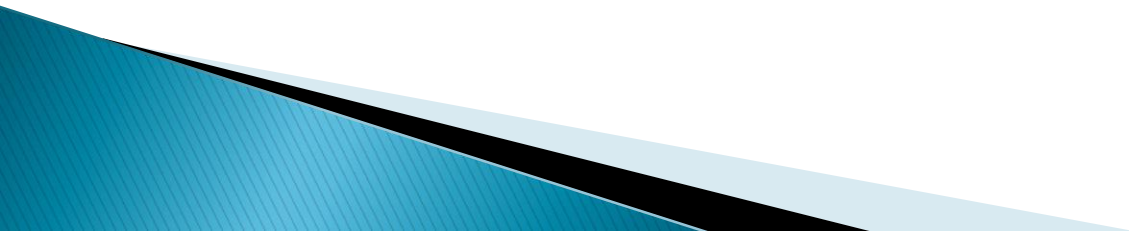
*Nuisance flooding threshold for Monroe County is 1.08 ft above MHHW, as defined by Sweet et al. (2014)

Sweet, W., J. Park, J. Marra, C. Zervas, and C. Gill. 2014. Sea Level Rise and Nuisance Flood Frequency Changes around the United States. NOAA Technical Report NOS CO-OPS 073.



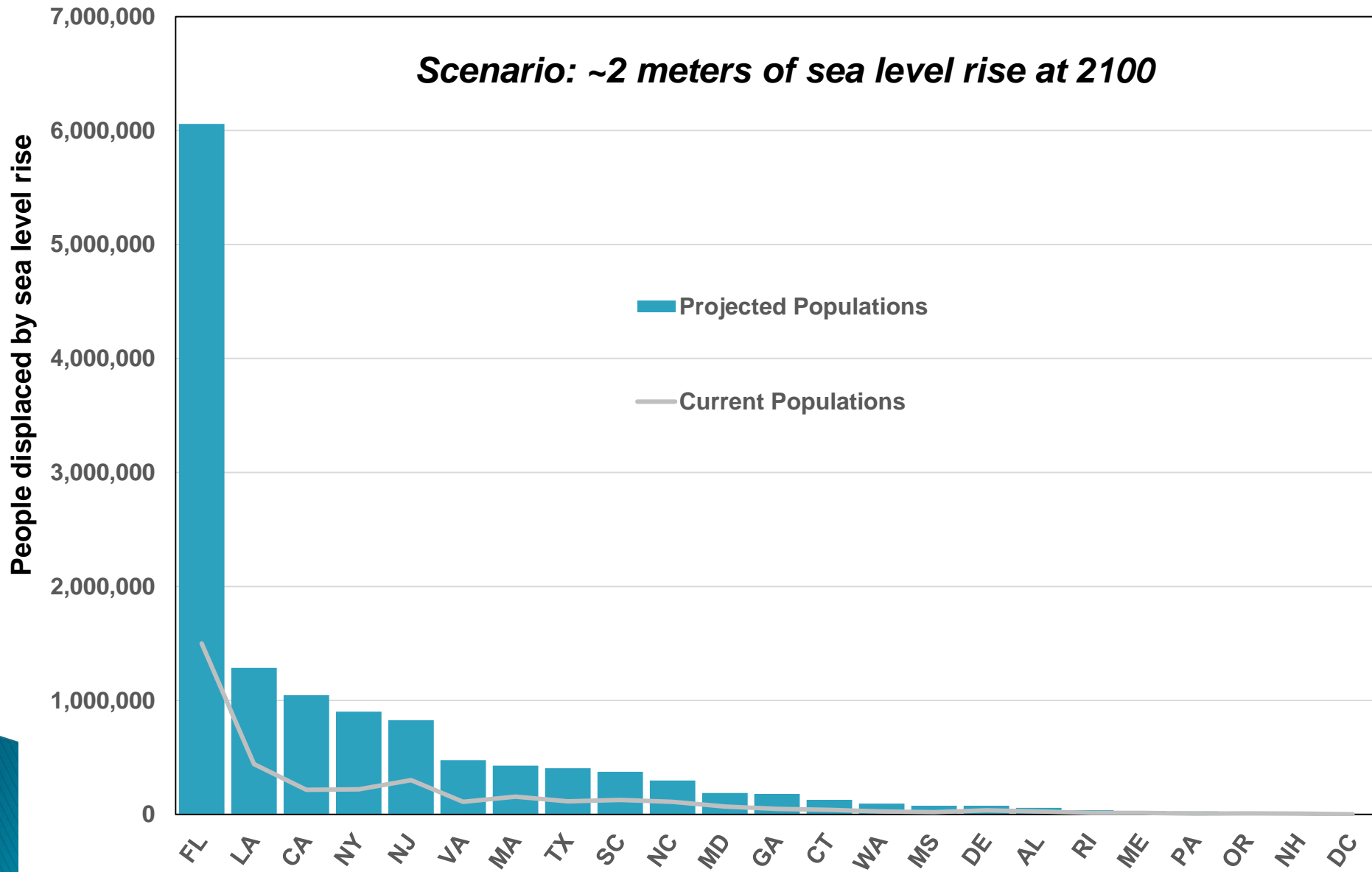
Assertion #2

Very few development decisions being made today in vulnerable coastal communities are considering the consequences in a worst-case scenario at 2100.

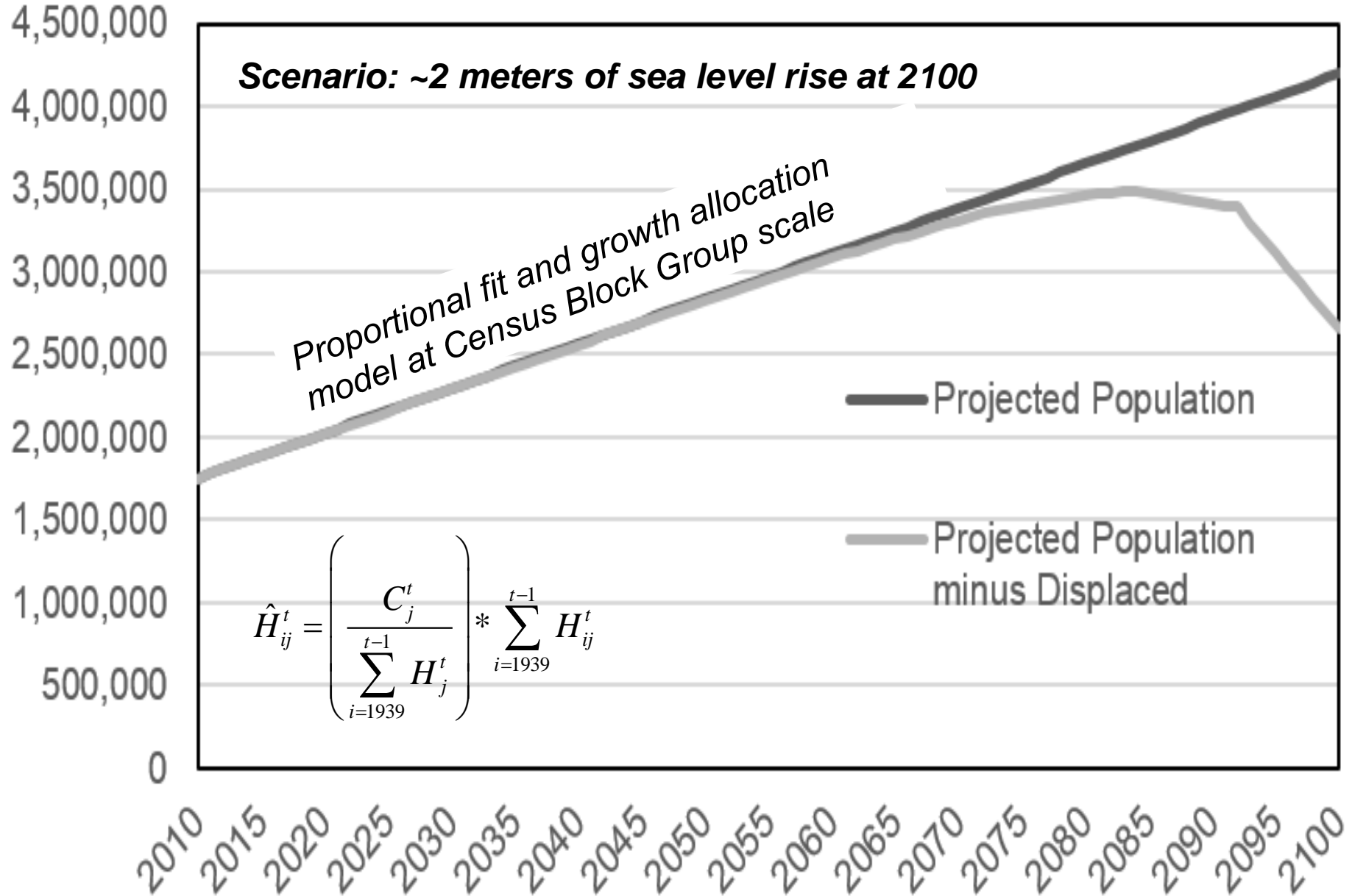


[illegible]

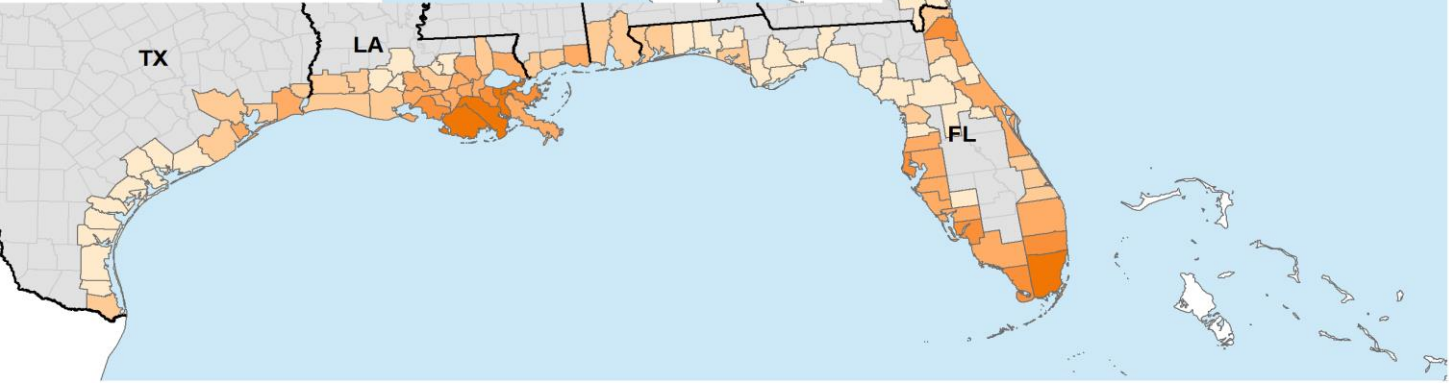
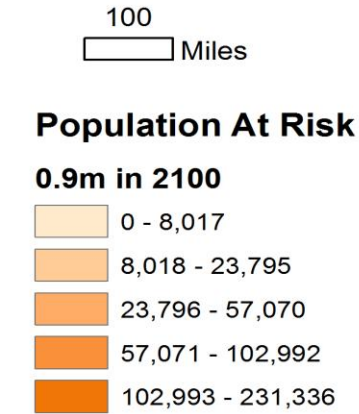
Population growth = Underestimation of problem



Broward, FL



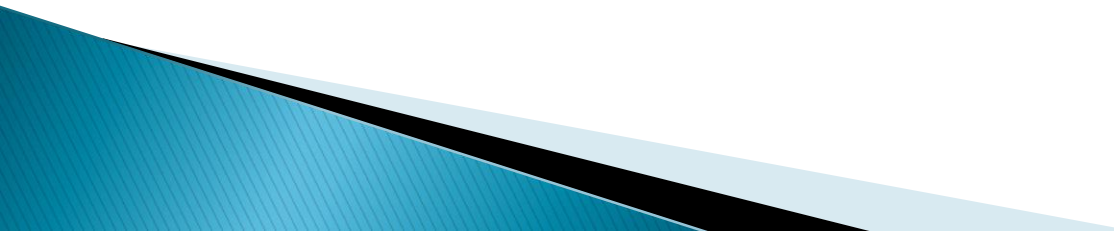
*Credit: M.J.
Hauer, J.M. Evans
and D. Mishra*



Assertion #2

Very few development decisions being made today in vulnerable coastal communities are considering the consequences in a worst-case scenario at 2100.

This is understandable – even appropriate – given uncertainty about the future over such a long time-horizon.

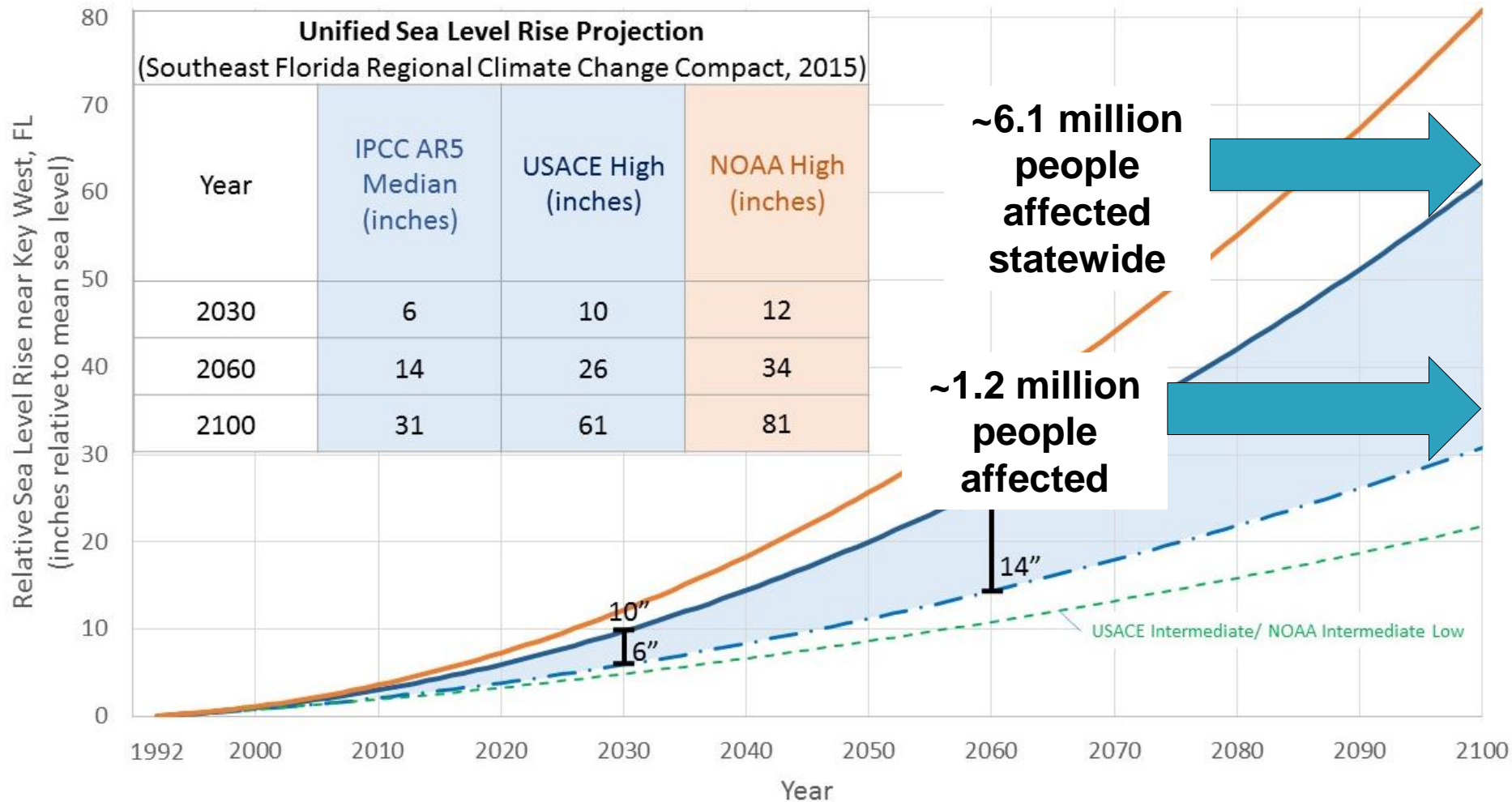




"Scientists have very high confidence that global mean sea level will rise at least 8 inches and no more than 6.6 feet by 2100."

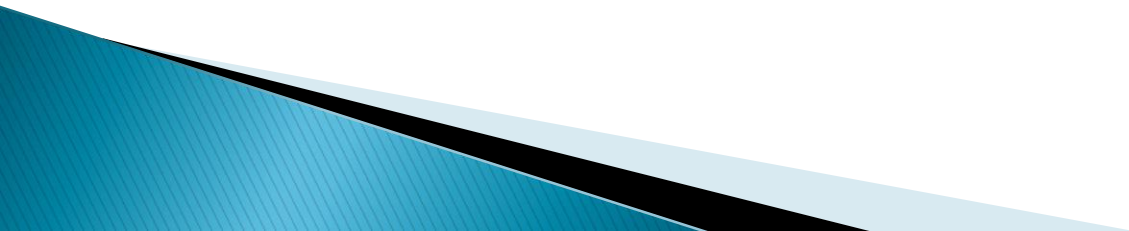
NOAA REPORT, DEC. 2012

BIG difference between low and high scenario

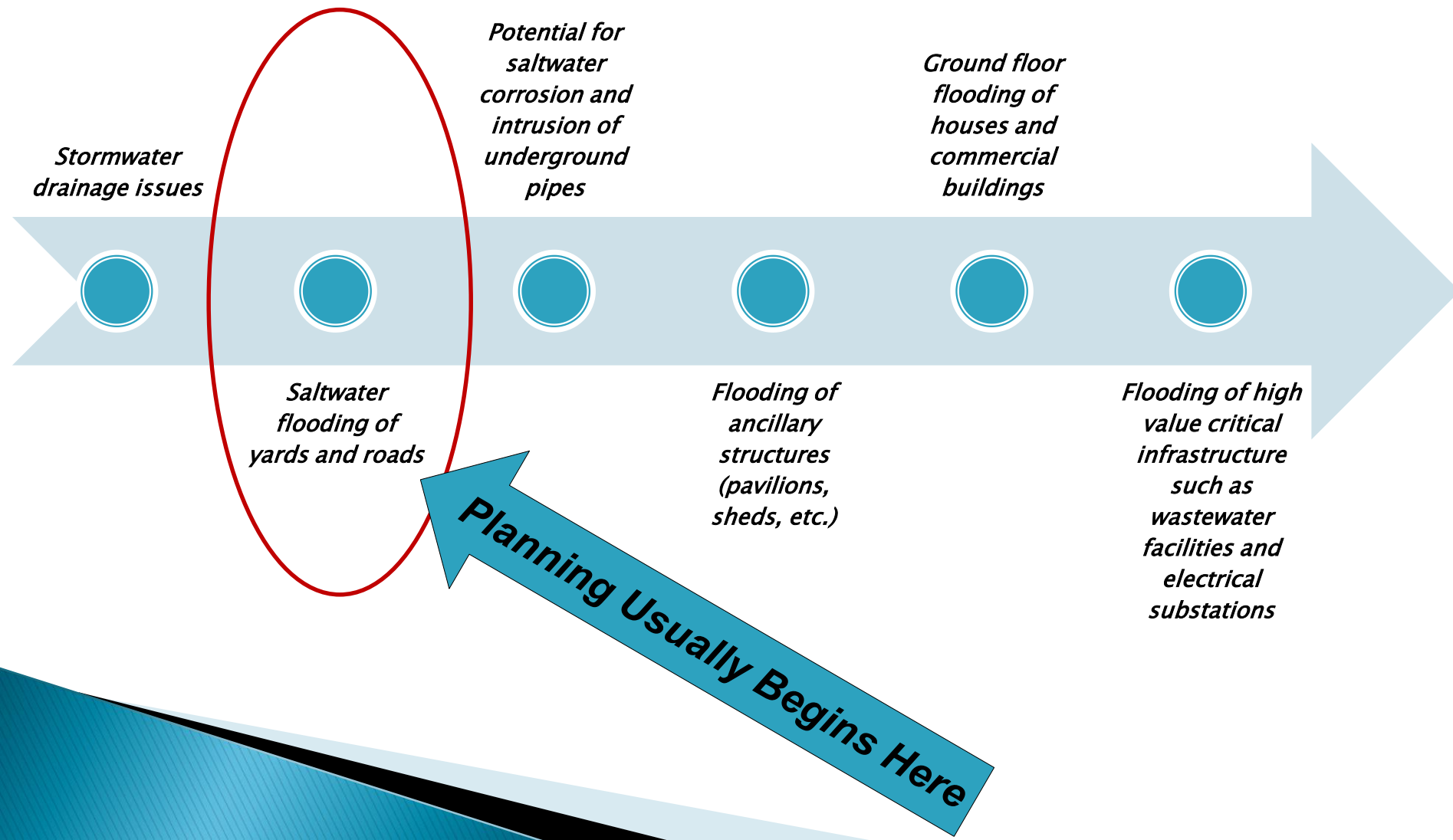


Assertion #3

People start to really take notice when roads start flooding on a sunny day.



General Timeline of Sea Level Rise Impacts on the Built Environment



*Tidal flooding on Tybee Island, GA
US Highway 80
October 27, 2015*



Third highest tide on record (since 1935) for this gauge

Only exceeded by tropical storm surges

September 29, 2015

**Photo credit: Greg
Corning, provided by
Monroe County staff**



**DEVELOPMENT OF A GEOGRAPHIC INFORMATION SYSTEM (GIS)
TOOL FOR THE PRELIMINARY ASSESSMENT OF THE EFFECTS OF
PREDICTED SEA LEVEL AND TIDAL CHANGE ON TRANSPORTATION
INFRASTRUCTURE**

Based on FDOT Sea Level Rise
Sketch Tool *

Developed by University of Florida



**FDOT Contract# BDK75 977-63
September 2013
Final Report**



**Prepared by
Alexis Thomas
Dr. Russell Watkins
The GeoPlan Center
Department of Urban & Regional Planning
University of Florida**



**Funded by
Florida Department of
Transportation**

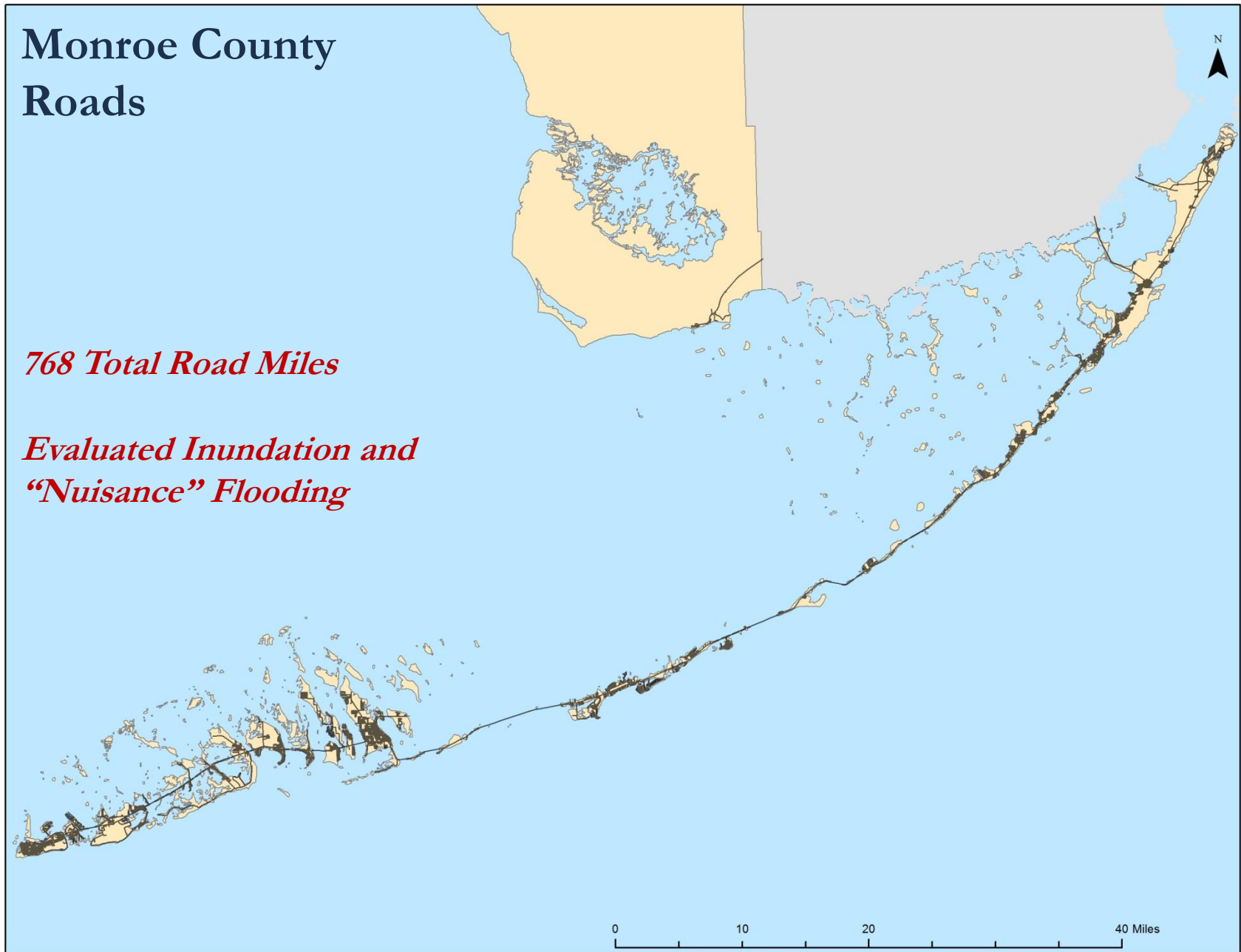
**General planning assessment tool requires
additional data for use in site-level decisions*

<http://sls.geoplan.ufl.edu/documents-links/>

Monroe County Roads

768 Total Road Miles

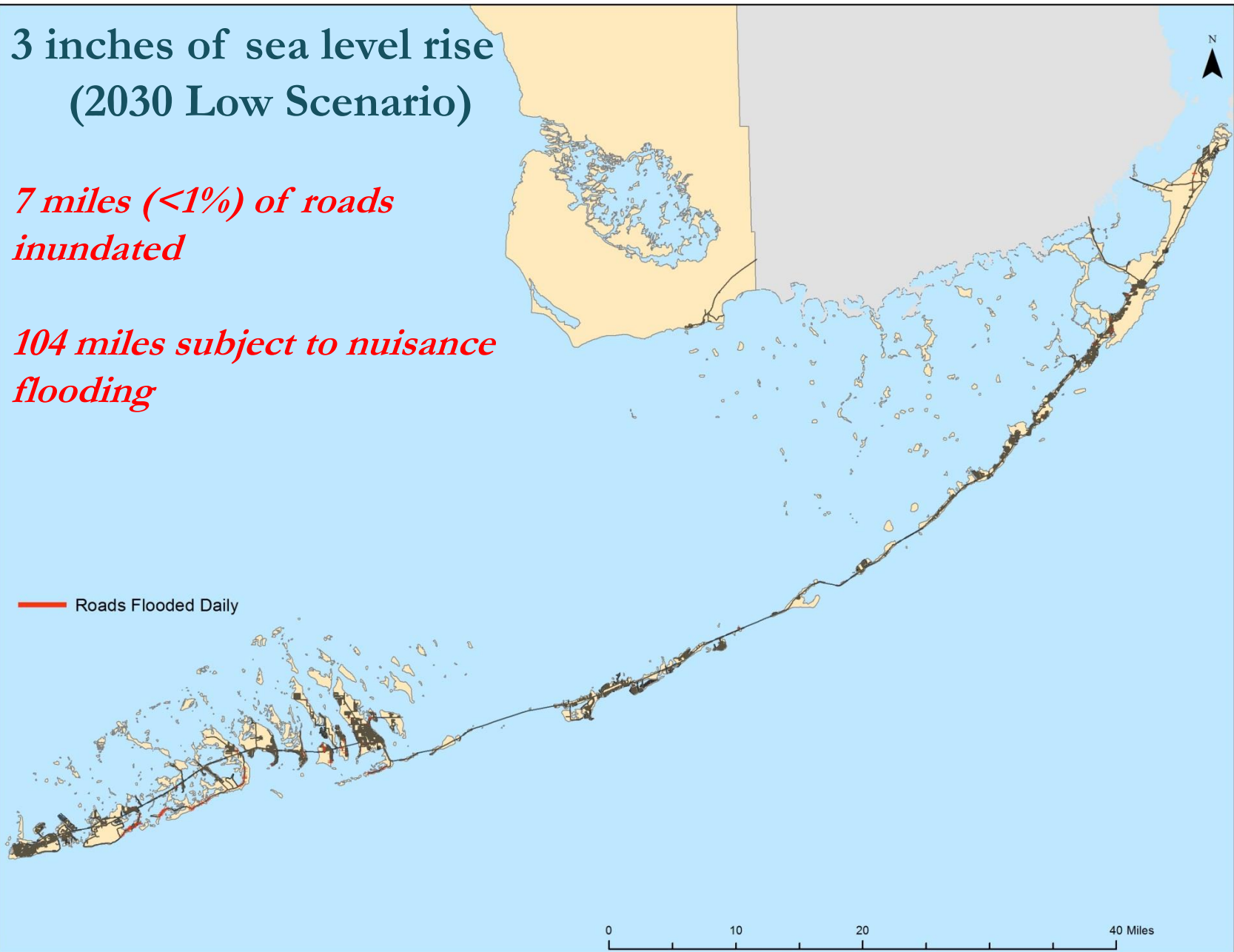
*Evaluated Inundation and
“Nuisance” Flooding*



3 inches of sea level rise (2030 Low Scenario)

*7 miles (<1%) of roads
inundated*

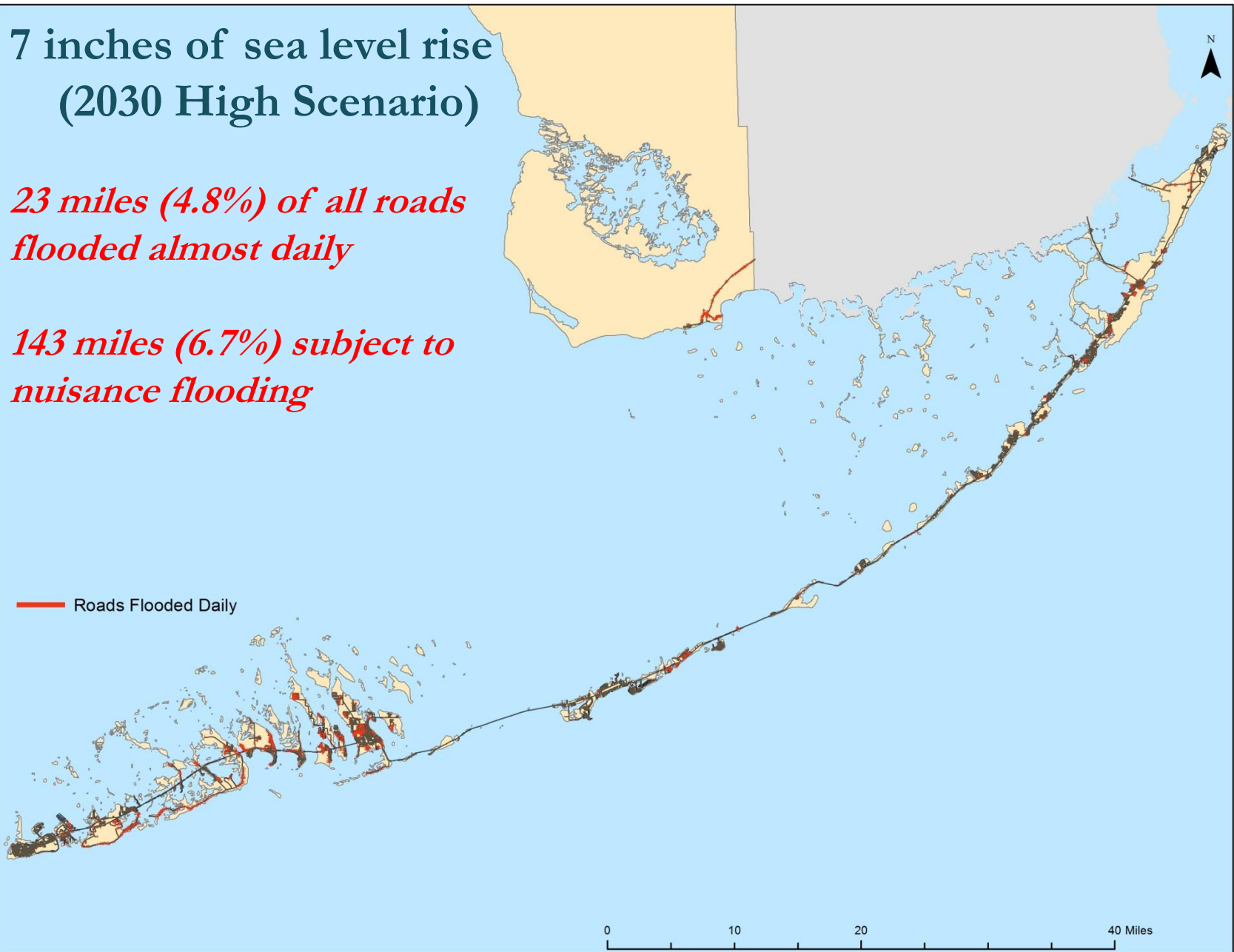
*104 miles subject to nuisance
flooding*

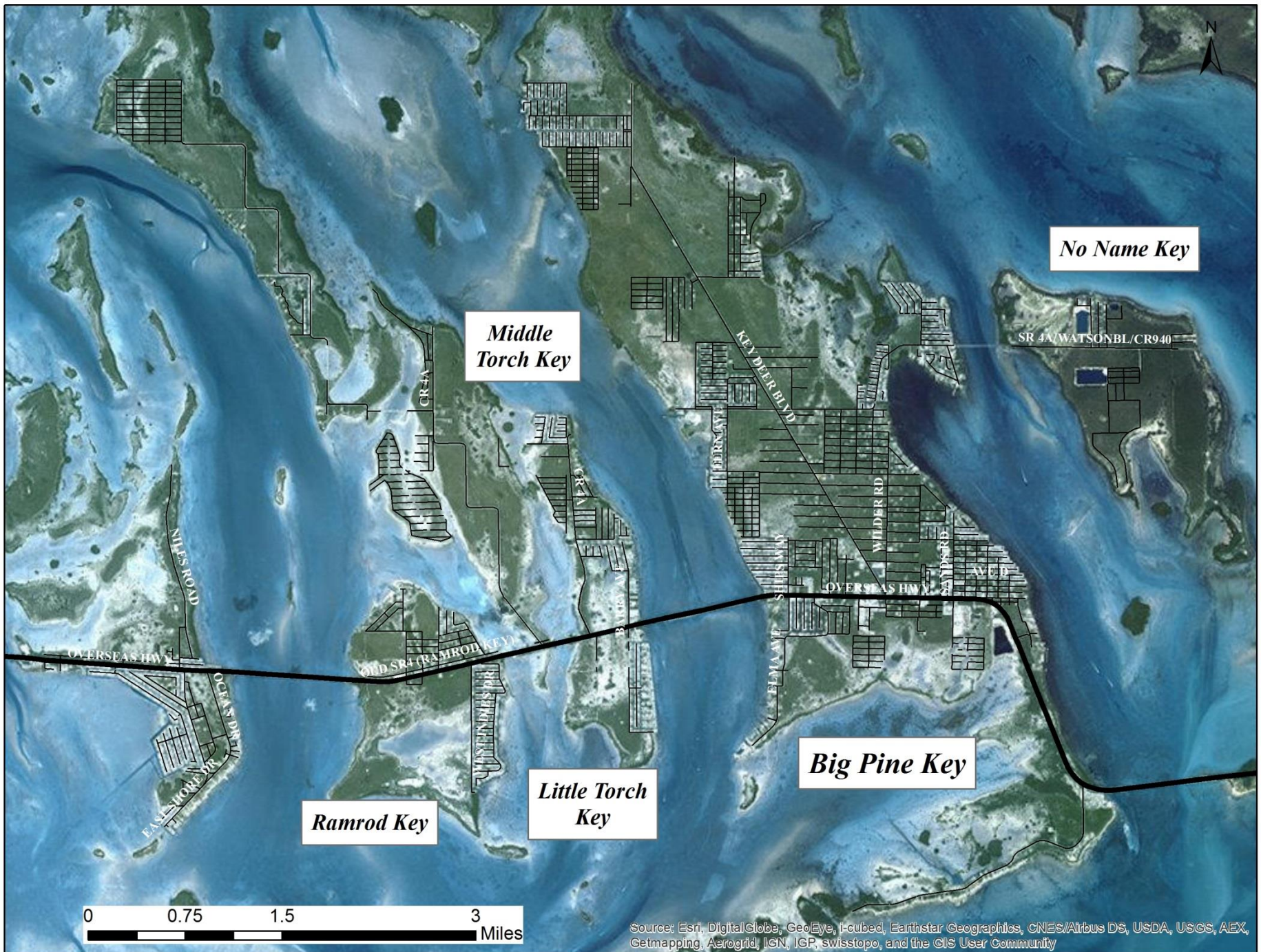


7 inches of sea level rise (2030 High Scenario)

*23 miles (4.8%) of all roads
flooded almost daily*

*143 miles (6.7%) subject to
nuisance flooding*





No Name Key

*Middle
Torch Key*

Big Pine Key

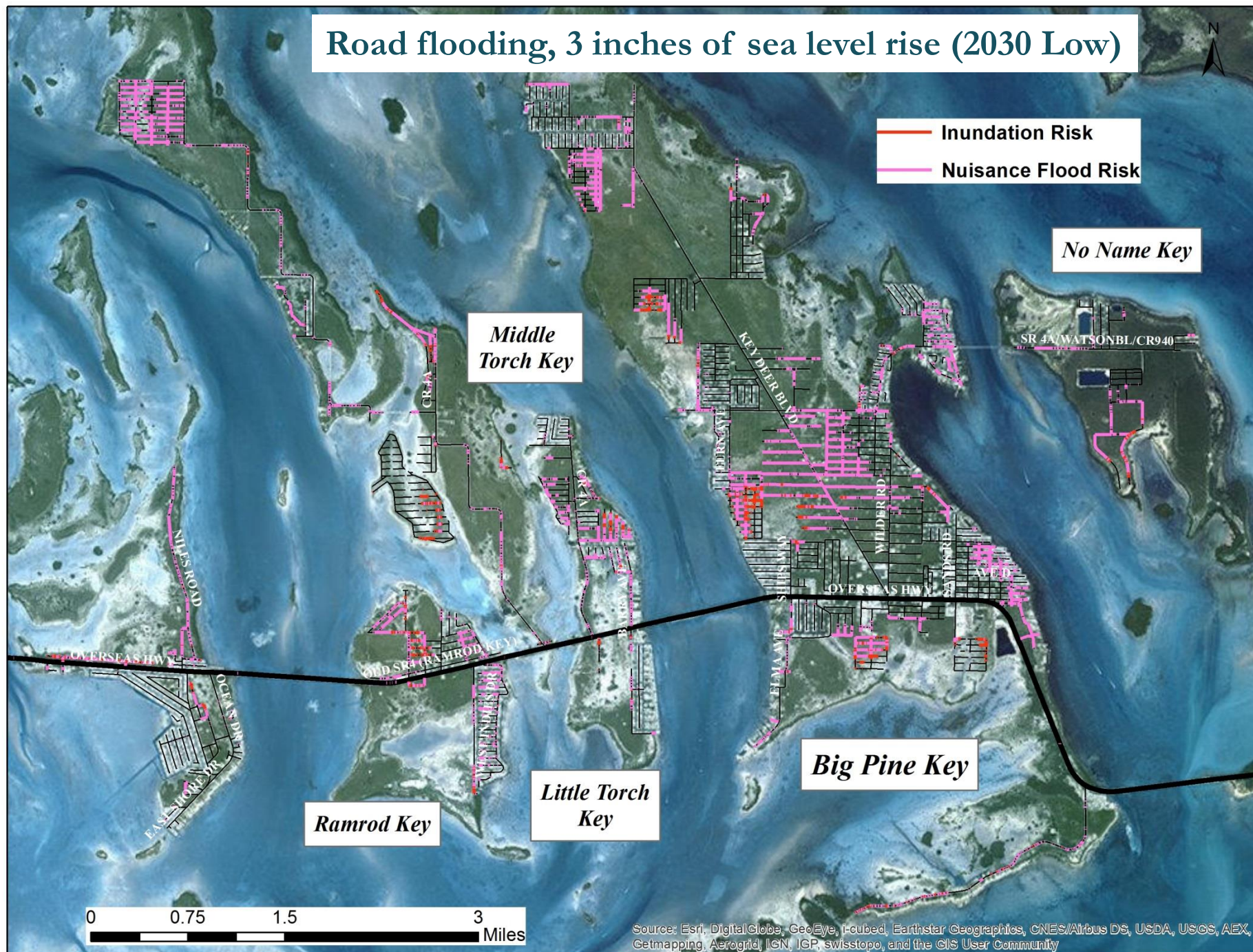
Ramrod Key

*Little Torch
Key*

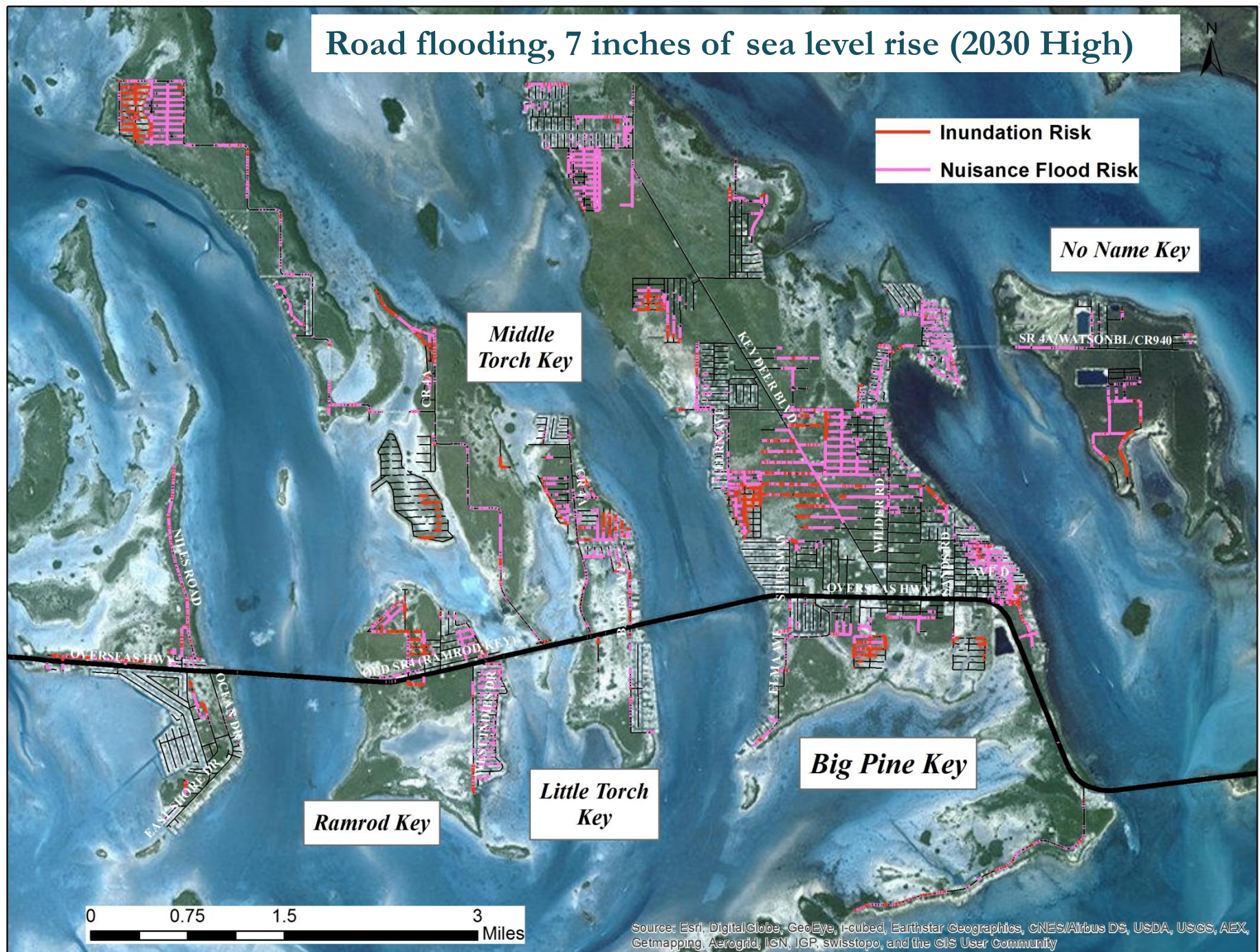
0 0.75 1.5 3
Miles

Source: Esri, DigitalGlobe, GeoEye, i-cubed, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, JGP, swisstopo, and the GIS User Community

Road flooding, 3 inches of sea level rise (2030 Low)



Road flooding, 7 inches of sea level rise (2030 High)



Modeling: More Accurate by the Day Policy

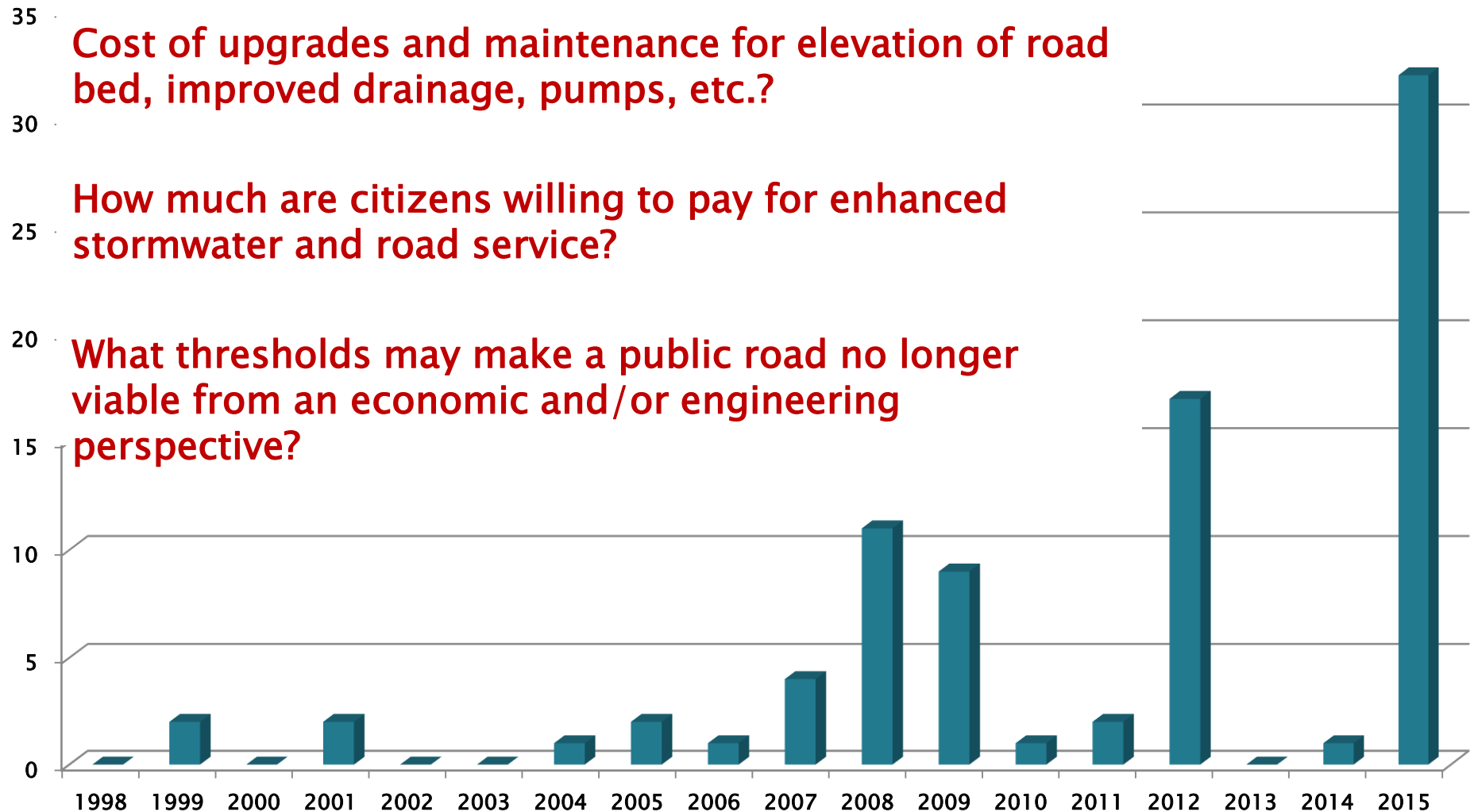
Framing: Much More Difficult

What is an appropriate level of service for maintaining stormwater and roads under sea level rise?

Cost of upgrades and maintenance for elevation of road bed, improved drainage, pumps, etc.?

How much are citizens willing to pay for enhanced stormwater and road service?

What thresholds may make a public road no longer viable from an economic and/or engineering perspective?



Thanks and acknowledgments

Monroe County, FL BOCC and staff

Tybee Island, GA City Council and staff

St. Marys, GA City Council and staff

Satellite Beach, FL City Council and staff

University of Florida GeoPlan: Crystal Goodison

University of Georgia: Mathew Hauer, Jill Gambill, Dr. Mark Risse, , Dr. Charles Hopkinson, Maddie Russell

Stetson University undergraduates: Emily Niederman, Justin Baumann, Zella Conyers, Alex Clark, Enric Cordoba, George Winsten



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UNIVERSITY