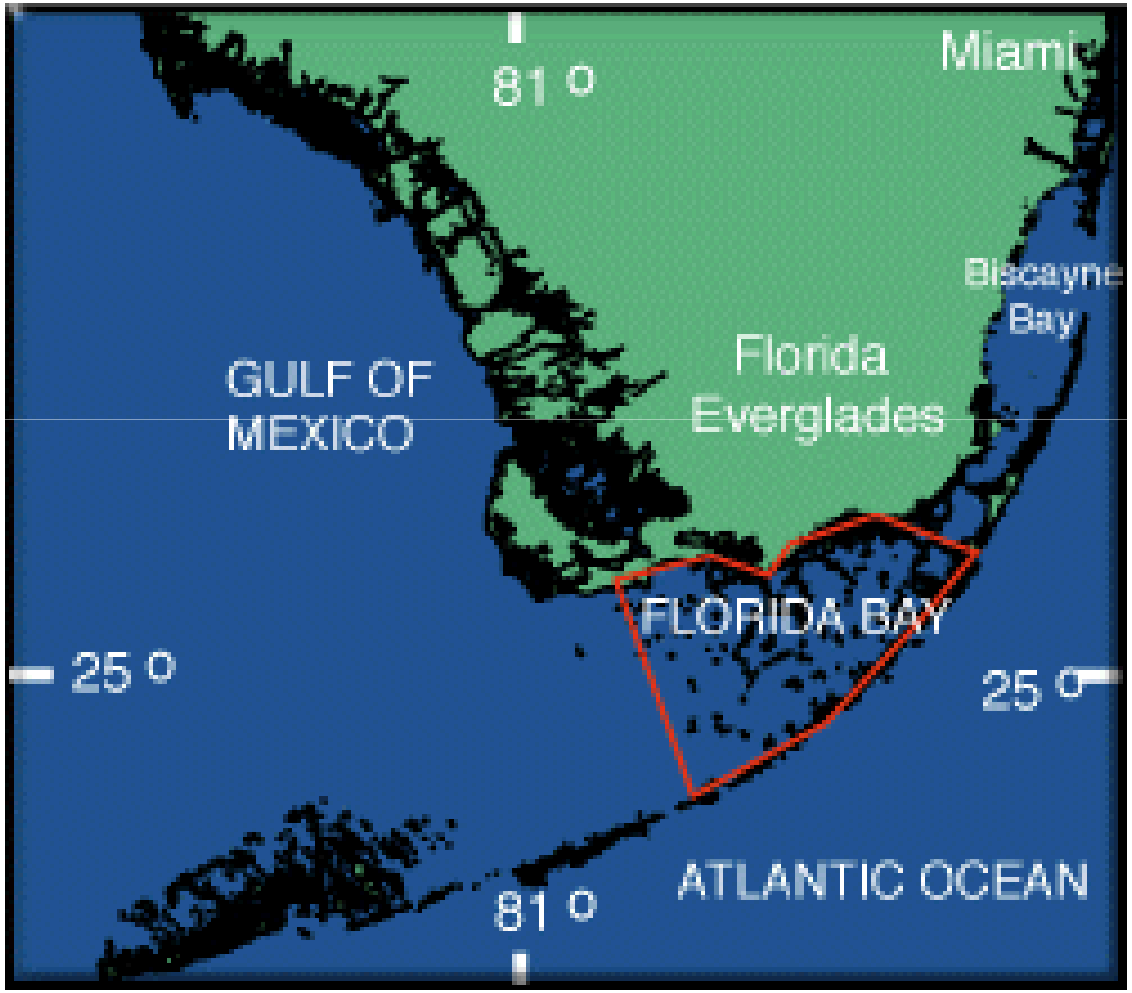
Correlating Qualitative with Quantitative Measurement of Sea Level Rise in Florida Bay

Douglas J. Leaffer, MSCE, PG, EIT



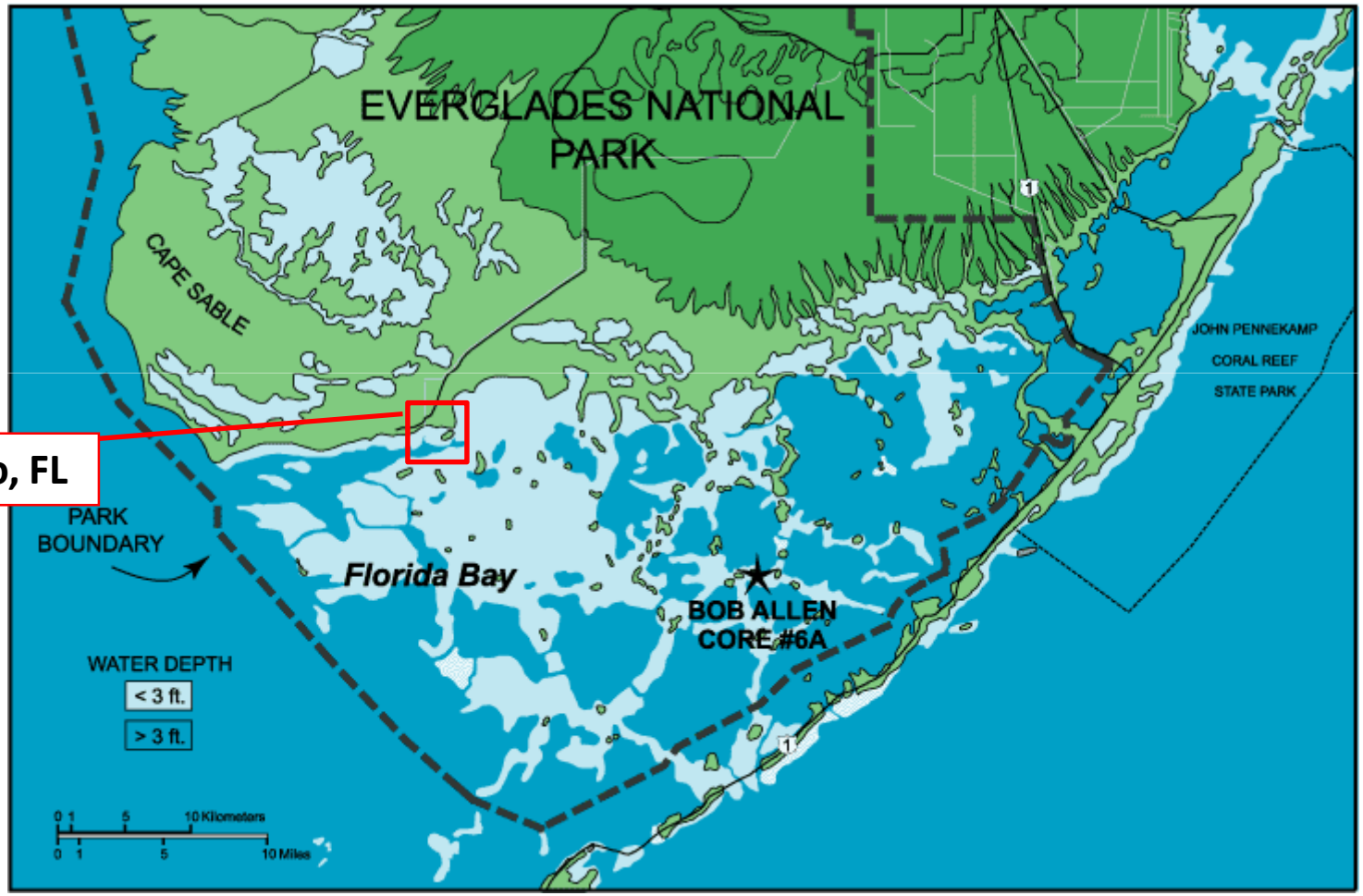
Framingham
State University

Area of Study



NOAA Gauging Station at Lat 24^{o} 42.7’ N, Long 81^{o} 6.3’ W

Florida Bay



Flamingo, FL

Vaca Key

Shallow Water, Sensitive Environment





Florida Bay with Fishing Guide





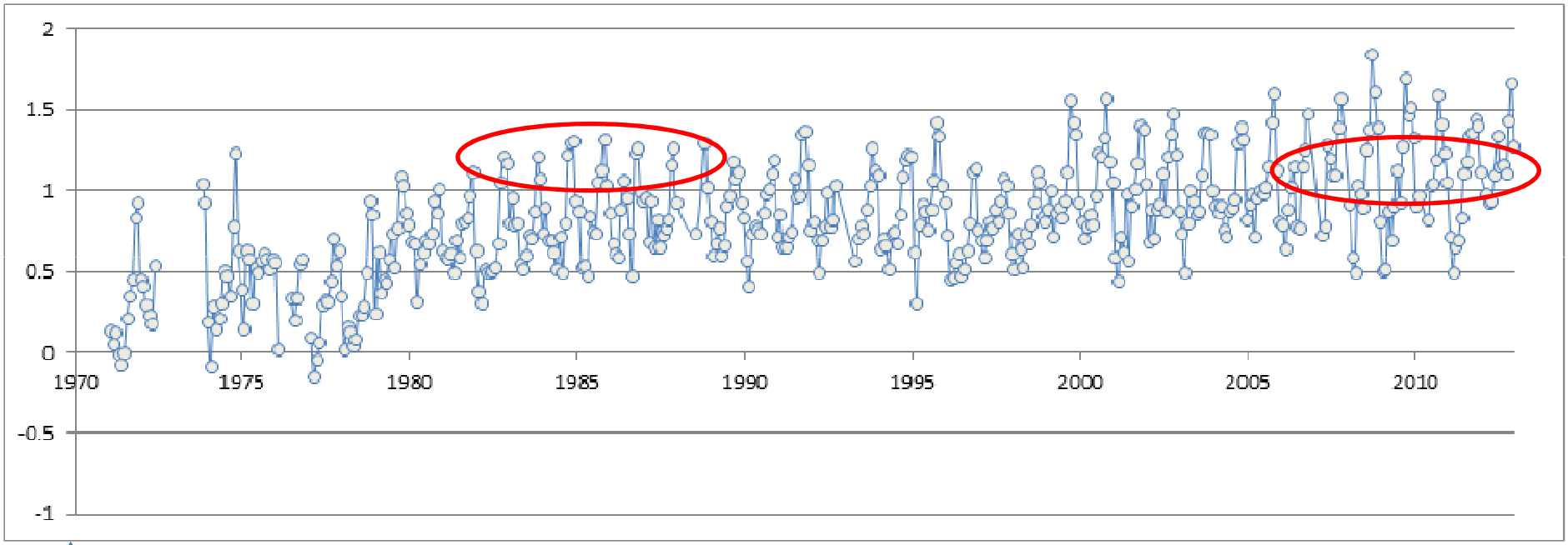
Boat Docks at Flamingo, Florida



Vaca Key, FL – NOAA Station 8723970

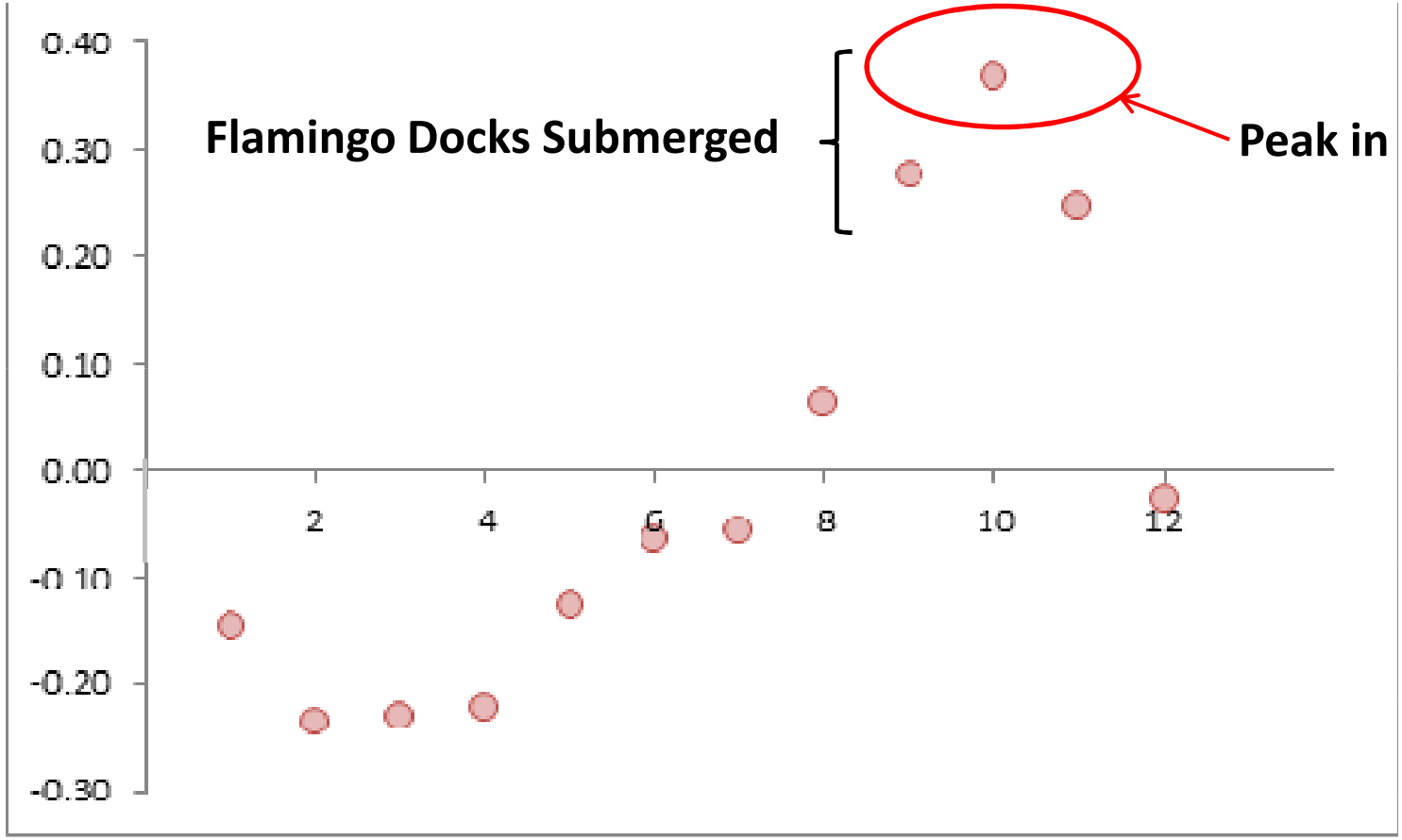


Monthly Mean Sea Level (MSL) Trend



Annual Fall Flood Heights in the 1980's are now Average Heights (2010's)

Avg. Water Height Variations by Month



NOAA Station # 8723970 - Data Shown are Heights in Feet +/- MSL (2012)

Qualitative Observations Today

- Dock submergence (Flamingo, FL) for 2 months / year compare to 2 -3 weeks (1980's) – per fishing guide
- Prolonged flooding a frequent event after strong storms (Miami Beach)
- Non-storm event seawater flooding during lunar high tides
- Significant beach erosion (Central FL southward to Miami-Dade County)
- Salt water intrusion into Biscayne Aquifer (since 1950's)

Source: Sea Level Rise and its Impact on Miami-Dade County, WRI Fact Sheet, 2014

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Rising seas mean shrinking South Florida future, experts say

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Under current projections, the Atlantic would swallow much of the Florida Keys and Miami-Dade in a century, according to experts at a sea-level rise summit

BY CURTIS MORGAN
CMORGAN@MIAMIHERALD.COM

The subject of global warming has become so politically unpalatable over the last few years that neither party mentions it much anymore.

A conference on climate change sponsored by Florida Atlantic University made it clear that ignoring the threat has done nothing to slow it down — particularly in South Florida, which has more people and property at risk by rising sea levels than any place in the country.

The two-day summit in Boca Raton, which wrapped up Friday, painted a bleak and water-logged picture for much of coastal Florida.

Homeland Security News Wire

BIOMETRICS BORDERS BUSINESS CYBERSECURITY D
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Infrastructure protection

Miami "Ground Zero" for risks associated with sea level rise

Published 7 May 2014

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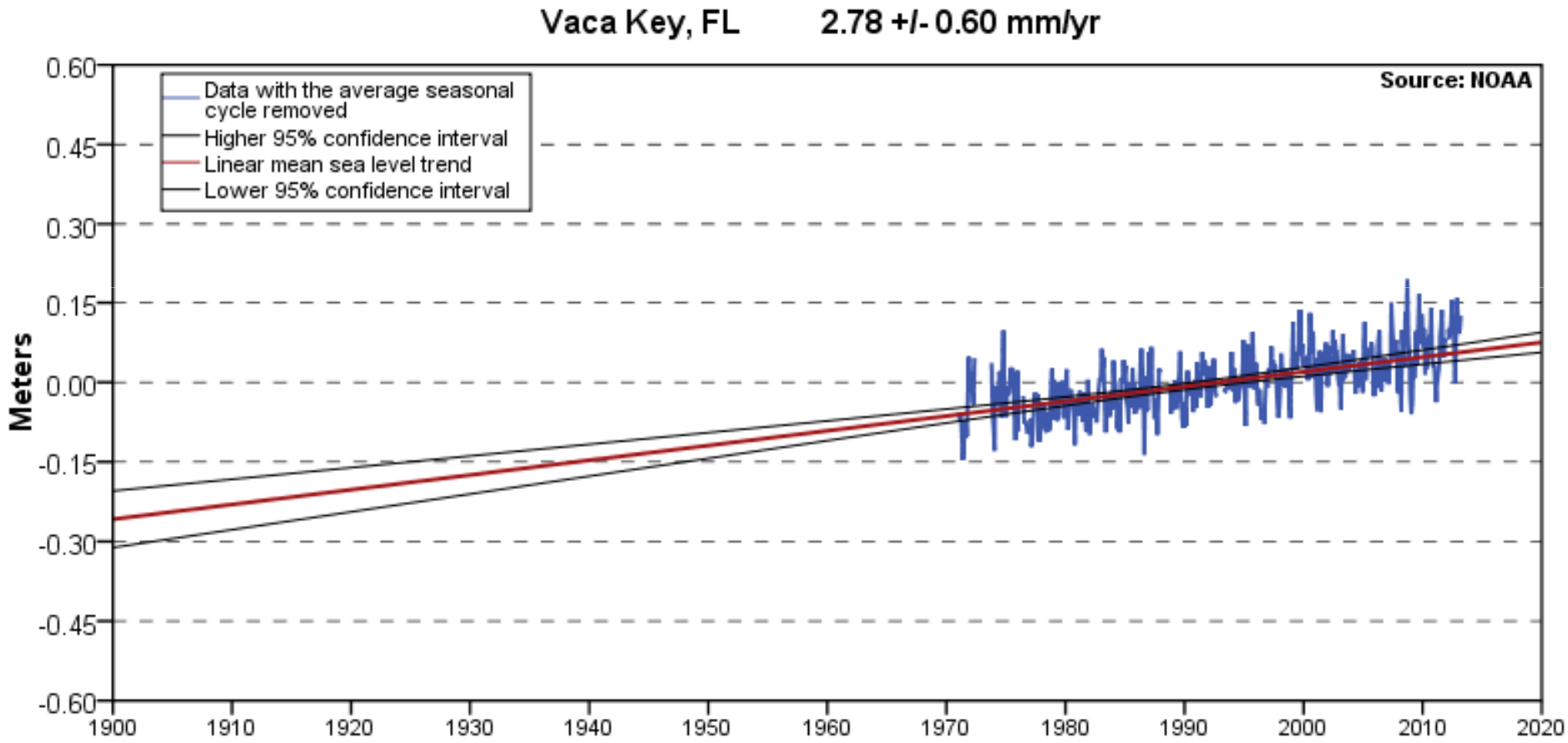
During a special Senate hearing last month in Miami Beach, Senator Bill Nelson (D-Florida) described Florida as "Ground Zero" for climate change and the threat it poses to coastal communities. Sea level rise is especially worrisome to Floridians because Miami has the most property assets at risk in the world, according to the World Resources Institute(WRI). Miami has $14.7 billion in beach front property. Also, fifteen million out of the state's twenty million residents live in coastal communities vulnerable to sea level rise.

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"Miami, as we know it today, is doomed," says Dr. Harold Wanless, Chairman of the Department of Geological Sciences at the University of Miami (*RollingStone:* 6/20/13)

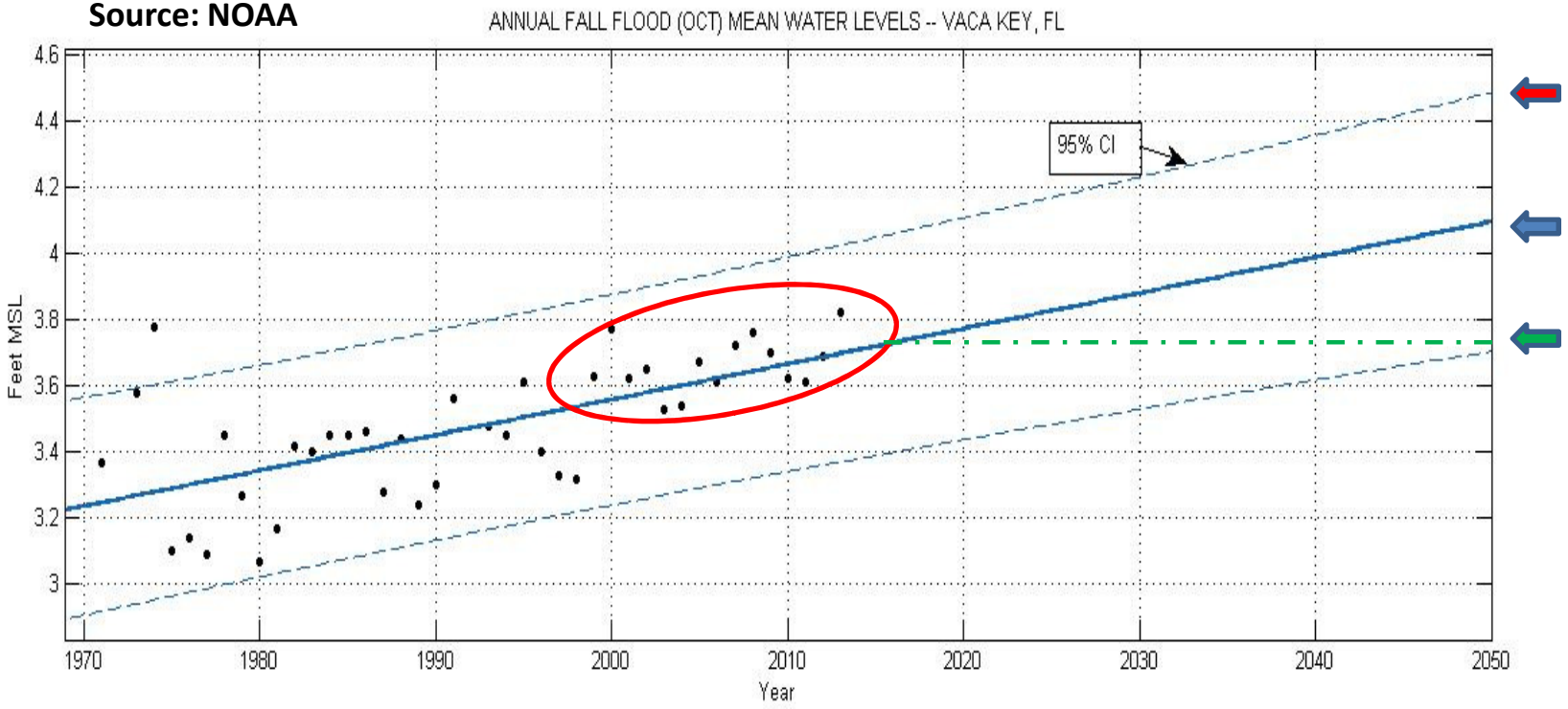
Statistical Monthly MSL Trend



Equivalent to a Sea Level Rise of 0.91 feet in 100 years

Annual Fall Flood Mean WL Forecast 2015-2050

Source: NOAA



Note: Dampening Amplitude of Annual Fall Flood Oscillations

Existing Flood Risks - South Florida

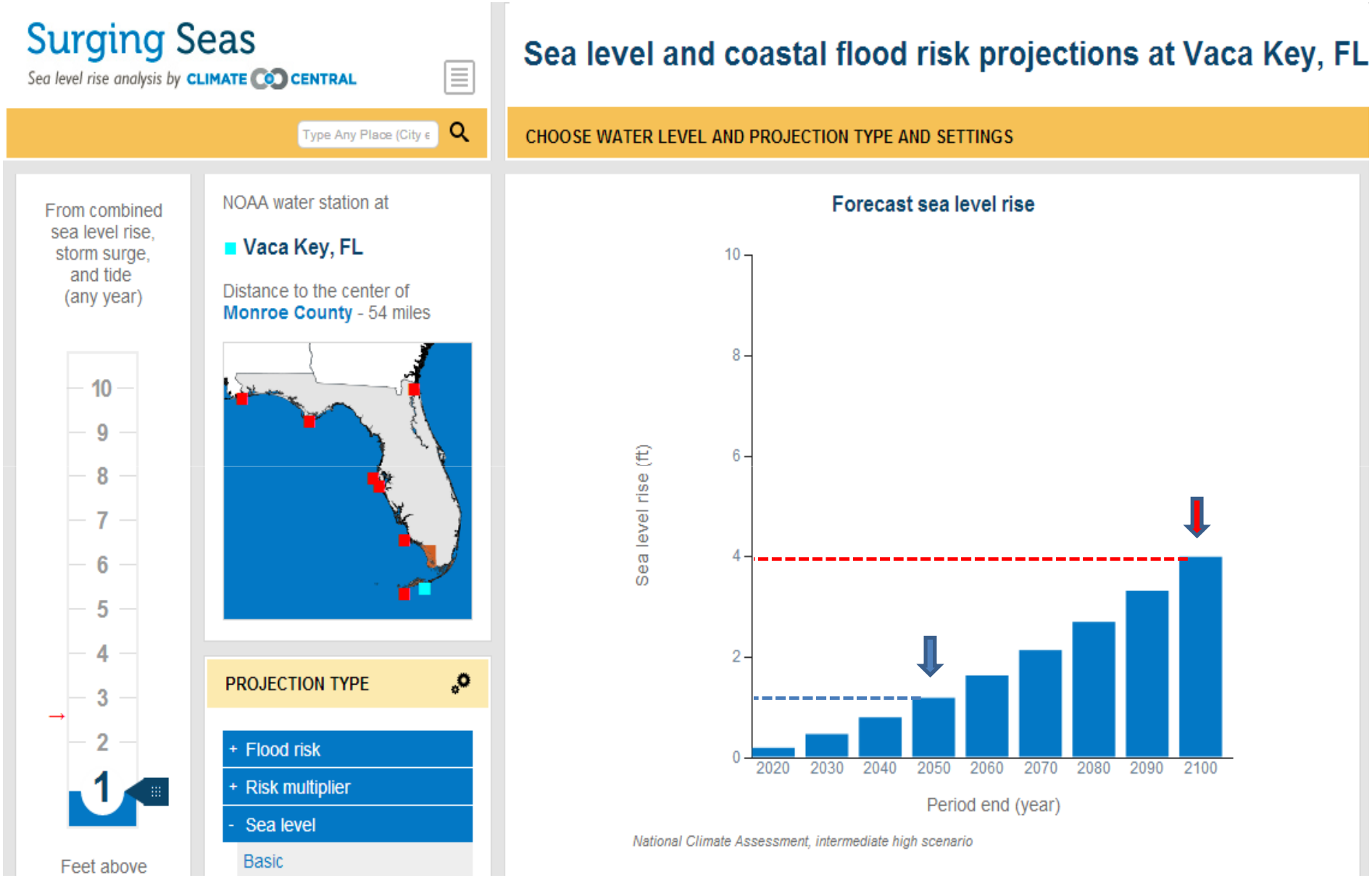
- Every coastal flood today is already wider, deeper and more damaging, due to
- roughly 8 inches of warming-driven global sea level rise recorded since 1900 (IPCC 2013)
- This rise has already increased the annual chance of extreme coastal floods threefold at Key West, a proxy for Southeast Florida

Source: Florida & the Surging Sea, A Vulnerability Assessment. Climate Central, 2013

Climate Central Projections

- Eight water level stations around coastal Florida
- Projections across the locations varied only slightly
- Analysis projects a range of local sea level rise
  - 0.6-1.3 feet by 2050, and
  - 1.7-4.7 feet by 2100, at Key West (MSL 2012 baseline)
- End-of-century projections at the seven other water level stations range from:
  - 3 inches lower (Apalachicola) to about
  - 2 inches higher (Vaca Key)

Source: Florida & the Surging Sea, A Vulnerability Assessment. Climate Central, 2013

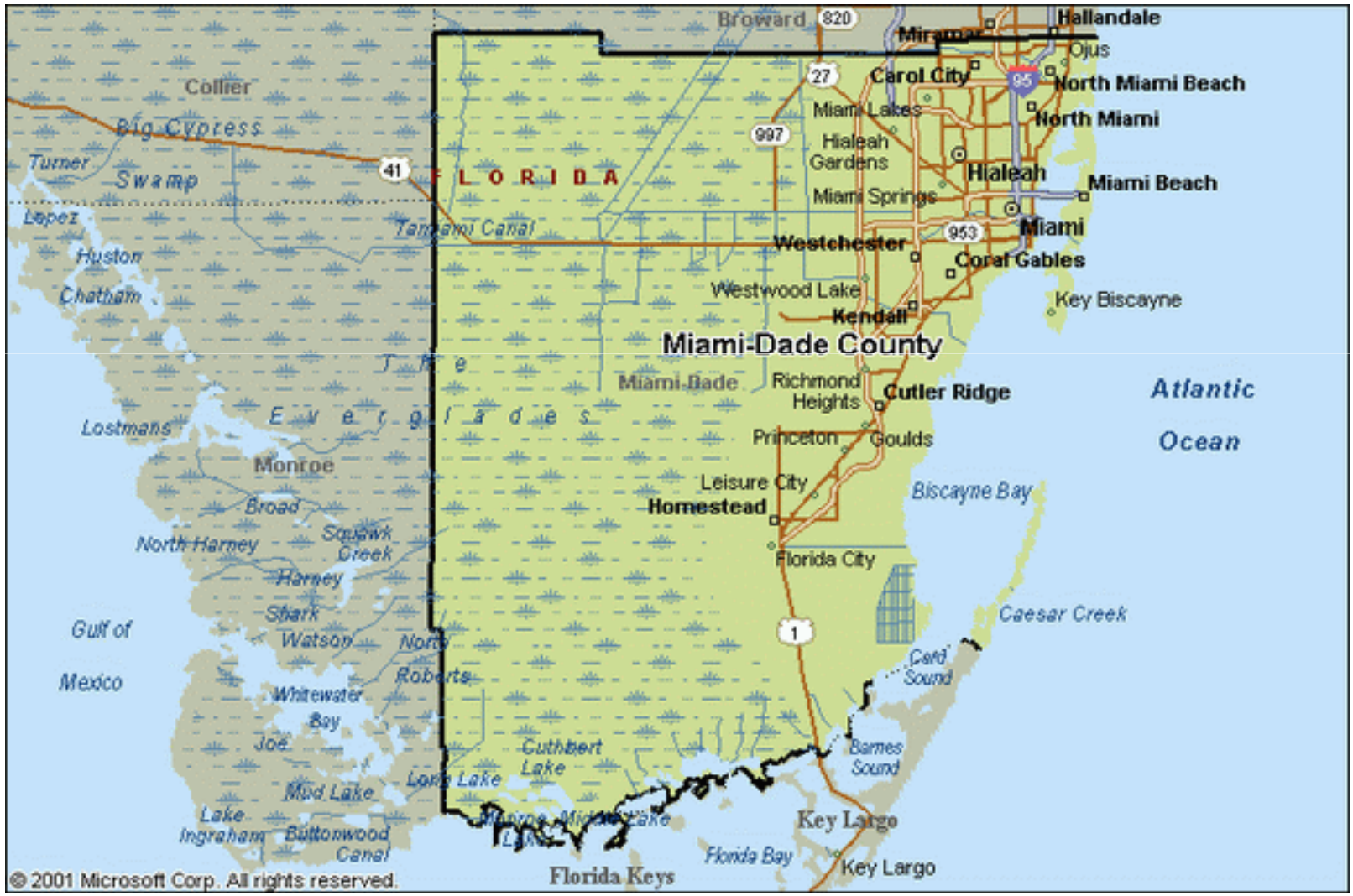


Source: Florida & the Surging Sea, A Vulnerability Assessment. Climate Central, 2013

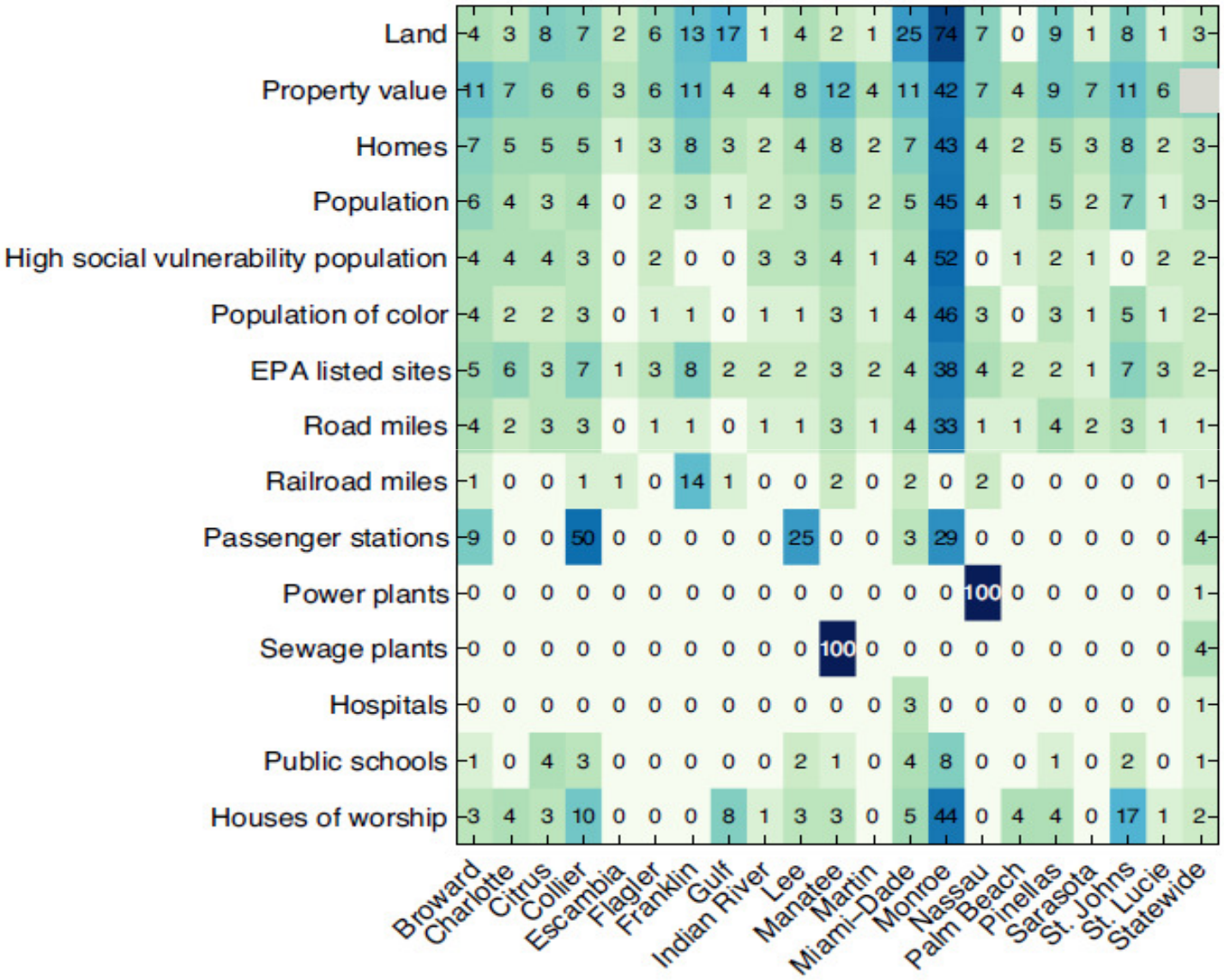
Populations and Receptors at Risk

- Miami-Dade alone has more people living less than 4 feet above sea level than **any state in the nation** except Louisiana
- More than 10 percent of land in Miami-Dade sits at less than 1 foot above current sea level,
  - nearly 20 percent at less than 2 feet, and
  - one-fourth at less than three feet.
- Homes, businesses, roads, infrastructure, wastewater treatment facilities, hazardous waste sites

Map of Miami-Dade County



People, Property and Infrastructure on Land < 3 ft. (% pop.)



Source: Florida & the Surging Sea, A Vulnerability Assessment. Climate Central, 2013

Adaptation and Mitigation

- Current pattern of development and housing density may reflect attempts to steer clear of historic flood risk
- Roughly 23 million cubic yards of beach renourishment needed over the next 50 years to sustain aesthetic and tourism viability of South Florida beaches
- Addition of high-capacity pumping stations costing approximately $70M each (plus necessary land acquisitions) to augment existing flood/salinity control structures
- Stormwater management, recapture and storage
- Construction of higher seawalls

Conclusions

- Since 1870, average global sea level rise of 8 inches
- In Southeast Florida, sea level has risen 12 inches
- Qualitative observations today demonstrate SLR is occurring in “real-time”
- By the year 2060, it is estimated that sea levels along Florida’s coastline could rise between another 9 inches to 2 feet
- Major impacts to population, property, infrastructure
- Mitigative measures and adaptation in progress

Source: Sea Level Rise and its Impact on Miami-Dade County, WRI Fact Sheet, 2014

Florida Bay - an Environment at Risk





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