30-Years of FEMA Sea Level Rise Studies and Future Focus Areas

BRIAN BATTEN (STARRII)

MARK CROWELL (FEMA)

Outline

- Purpose of Study

- Brief history of FEMA SLR Studies

- What the community is doing

- Looking forward

Study Purpose

Inform future FEMA SLR and long-term erosion efforts, and compliment TMAC recommendations by:

- Summarizing key elements of previous efforts in one document

- Identifying achievements and limitations

- Reviewing external efforts to increase awareness
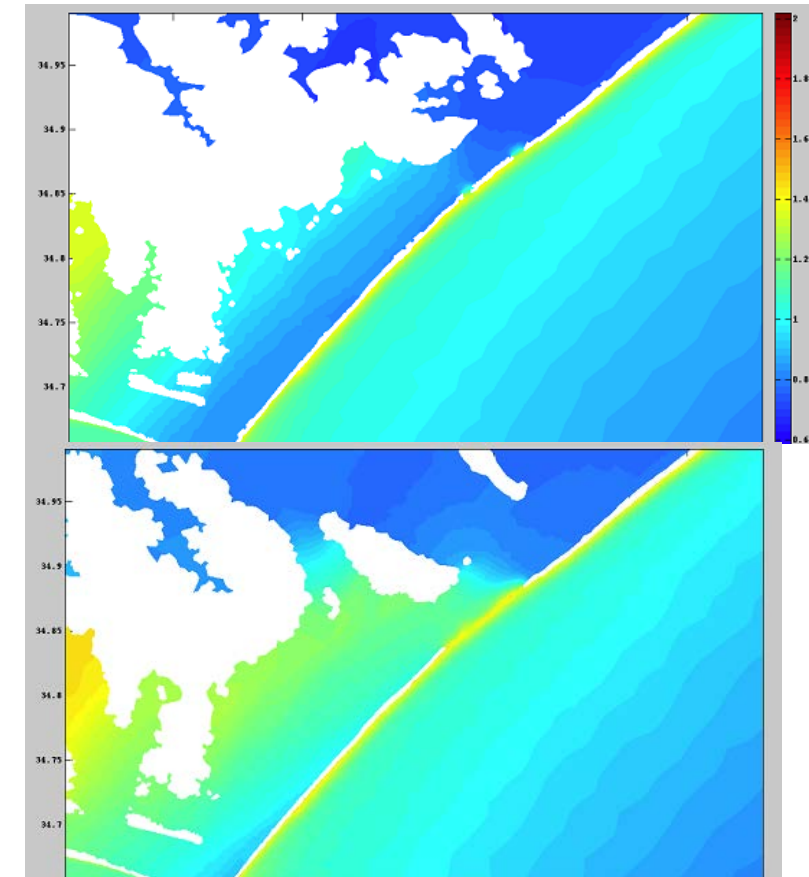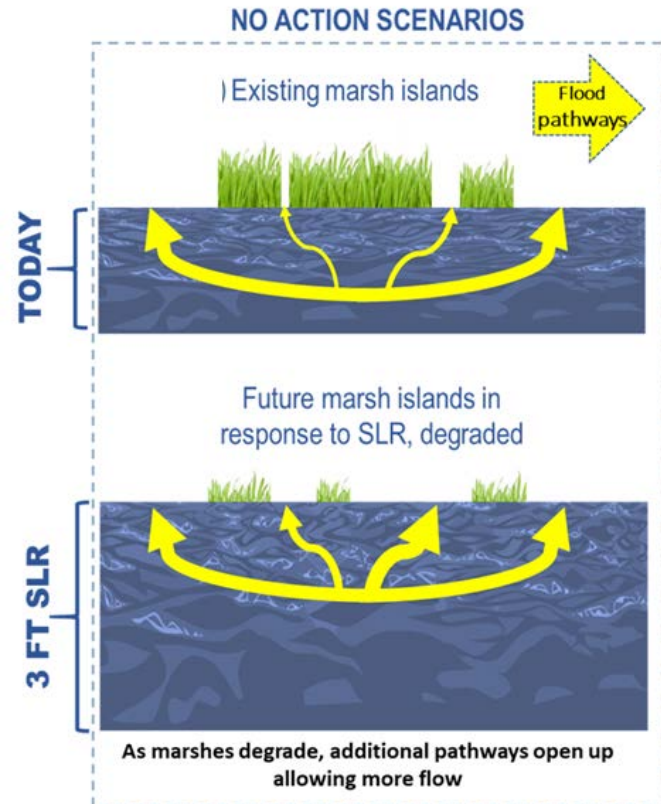
- Provide gap analysis, focus areas, and considerations for future efforts
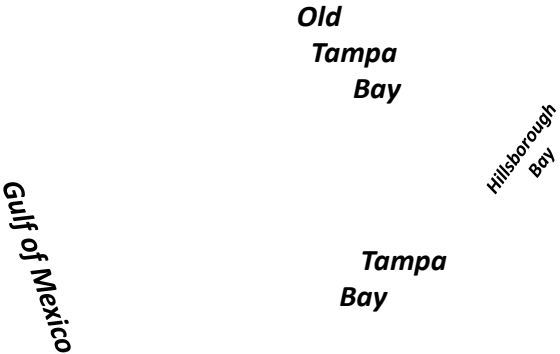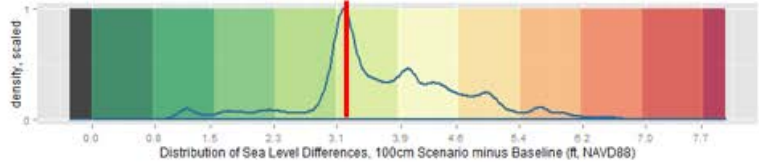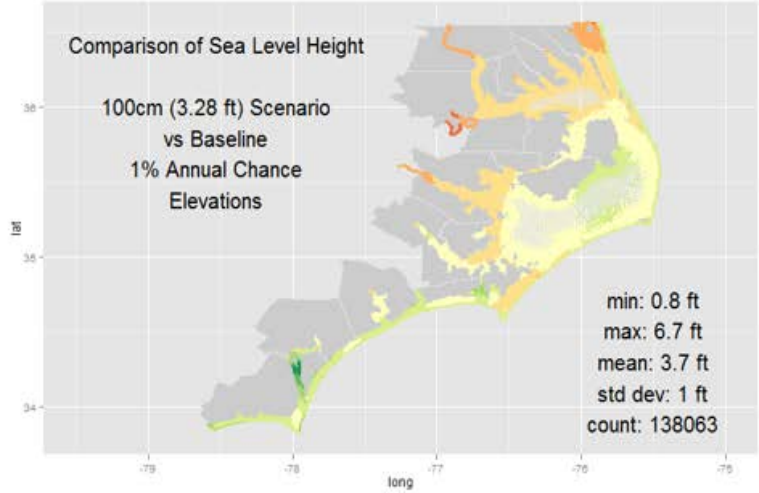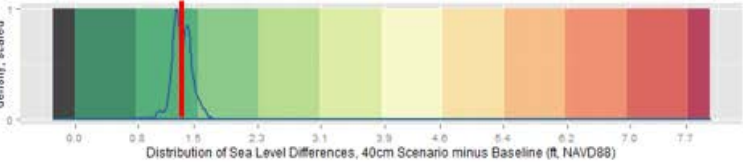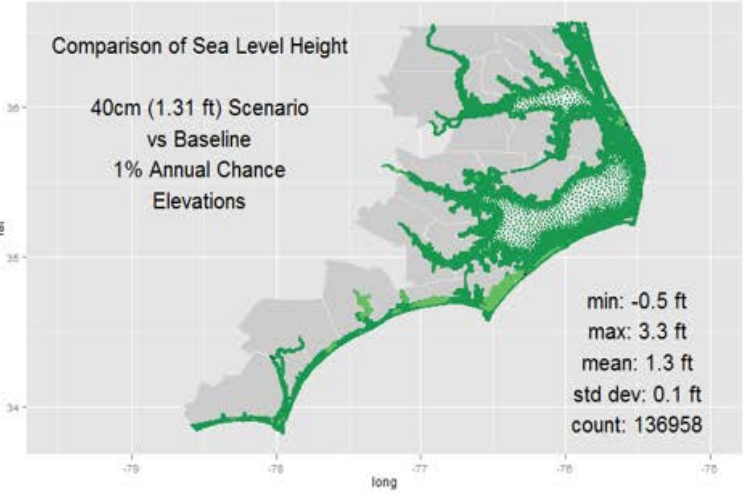
Review of FEMA SLR Studies

- Projected Impact of SLR on NFIP (1991)

- The Impact of Climate Change and Population Growth on the National Flood Insurance Program through 2100 (2013)

- North Carolina Sea Level Rise Impact Study (2009-2013)

- Sea Level Rise Tool for Sandy Recovery (2013)

- National Flood Insurance Program, Programmatic Environmental Impact Statement, Climate Change Elements (2015)

- FEMA SLR Pilot Studies
  - R2 - Puerto Rico (2010)
  - R9 - San Francisco, CA (2015)
  - R3 - Anacostia River & Prince George's Co, MD. (Riverine, 2016)
  - R4 - Hillsborough/Pinellas Counties, FL (2018)
  - R1 – Shoreline Change Pilot (2018-2019)

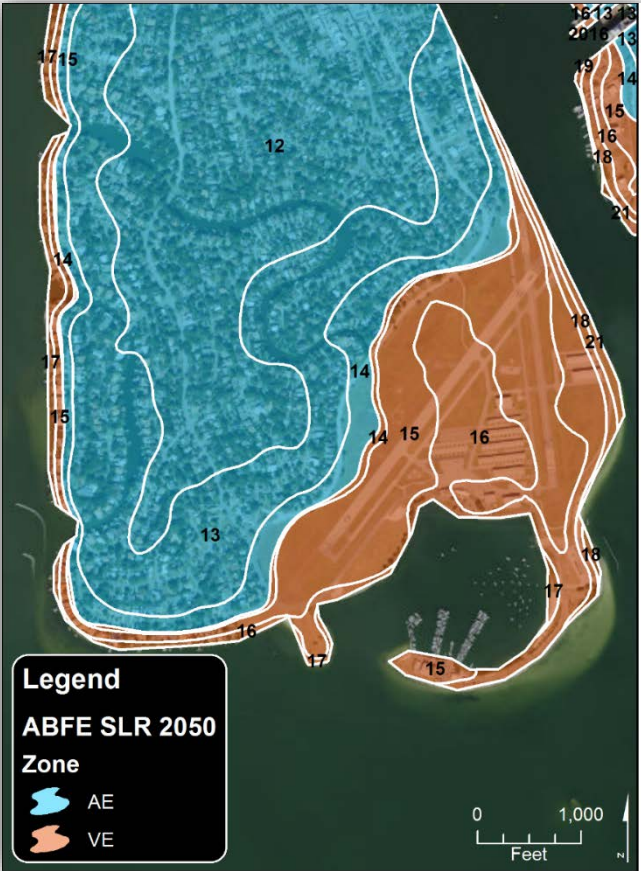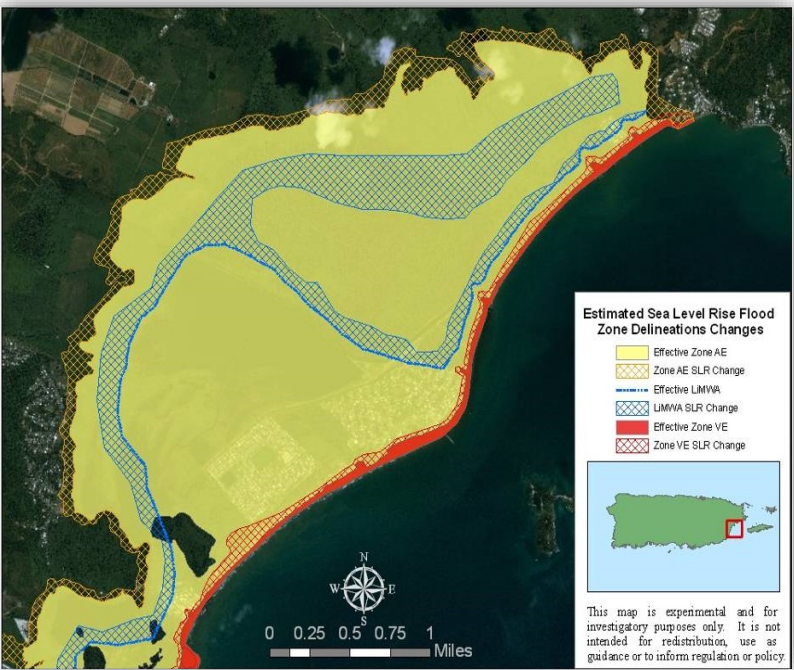| Study	SLR Integration into Surge Heights	Other Scope Elements	Key items
NATIONAL PROGRAMMATIC STUDIES			
Projected Impact of Relative Sea Level Rise on the National Flood Insurance Program	Approximate, linear superposition and proportional increases in floodplain	Future population Future shoreline position	Initial consideration of erosion
The Impact of Climate Change and Population Growth on the National Flood Insurance Program through 2100	Approximate, linear superposition and proportional increases in floodplain	Scale, goals of application Quantification of uncertainty Regional SLR analysis	Monte Carlo approach Simplified changes in storm frequency and intensity
Programmatic Environmental Impact Statement, Climate Change Analysis	Linear superposition	National mapping of future extent	Sub-regional SLR projections
METHOD/PRODUCT FOCUSED STUDIES			
Puerto Rico SLR Pilot Study	Linear superposition Dynamic Modeling	Depth-limited assessment Wave height modeling SLOSH	Modeled linear response Mapping concepts Conservative freeboard calculations
North Carolina Sea Level Rise Impact Study	Dynamic Modeling	Future storm frequency/intensity Future coastal landscape Future land development	Changes in non-linearity by scenario, surge pathways Increase in high-frequency floodplain Flood risk from future development
Sea Level Rise Tool for Sandy Recovery	Linear superposition		Tools to see both changes in extent and BFE Extensive use by stakeholders Differing scenarios by geography
Future Conditions Analysis and Mapping, San Francisco County, California	Dynamic	Long-term shoreline retreat Wave runup modeling	Pacific Coast Mapping Products integrating SLR and erosion Stakeholder Input Non-linearity by shore type
Incorporating Climate Change into Future Conditions Riverine Floodplain Modeling	Linear superposition	Transitional coastal to riverine areas	Non-linearity in tidal elevations Guidance for riverine modelers
Hillsborough & Pinellas Counties, Florida	Linear superposition Dynamic Modeling	Gulf of Mexico Long-term shoreline retreat Storm suite optimization Approximate methods for lower scenarios	Non-linearity by coastal environment Mapping products with future condition extent and BFE Large bay environment

What causes surge non-linearity?

NO ACTION SCENARIOS

Existing marsh islands

Flood pathways

TODAY

Future marsh islands in response to SLR, degraded

3 FT SLR

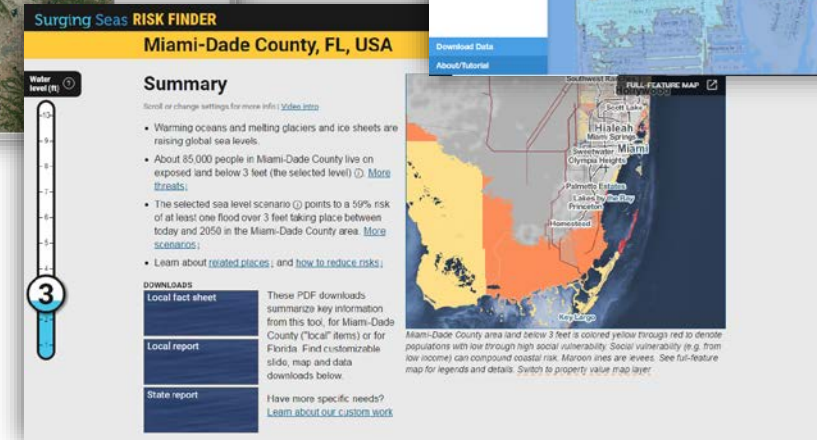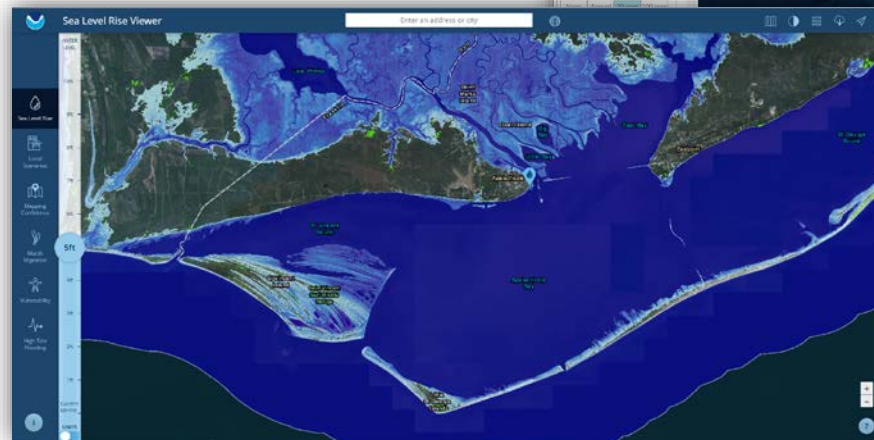As marshes degrade, additional pathways open up allowing more flow
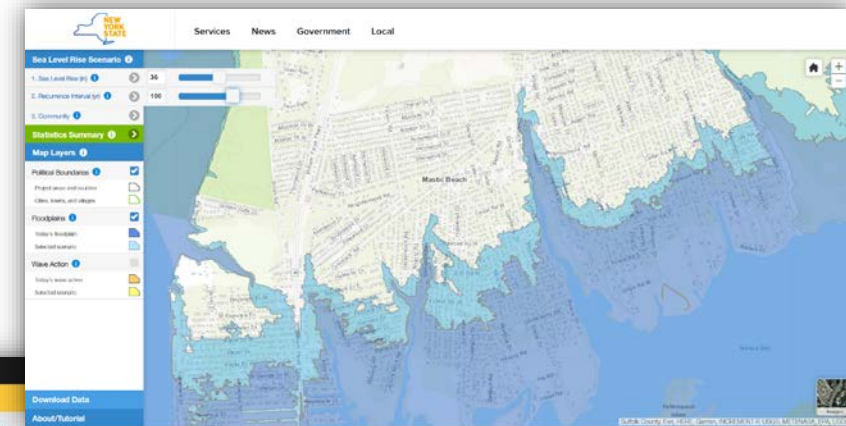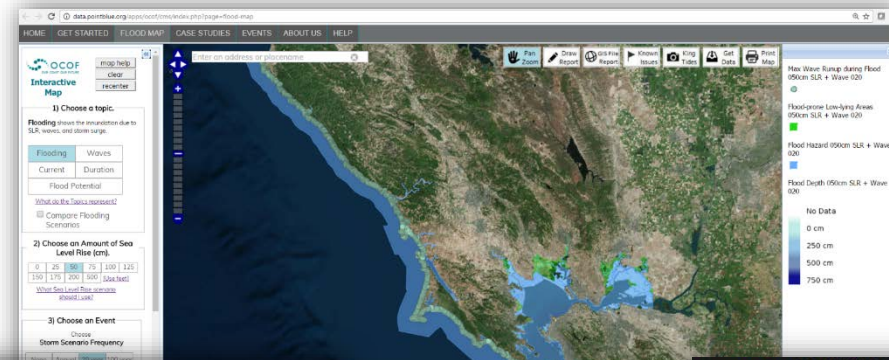
74TH Park Blvd N, Seminole, FL
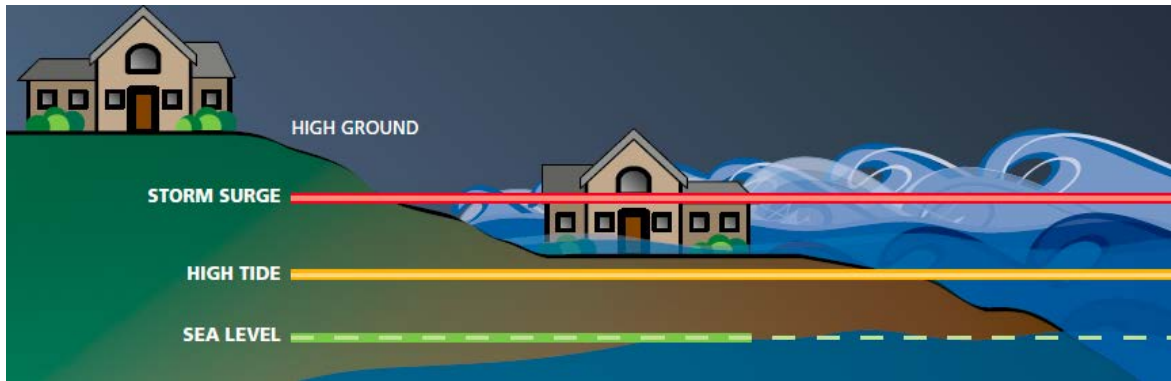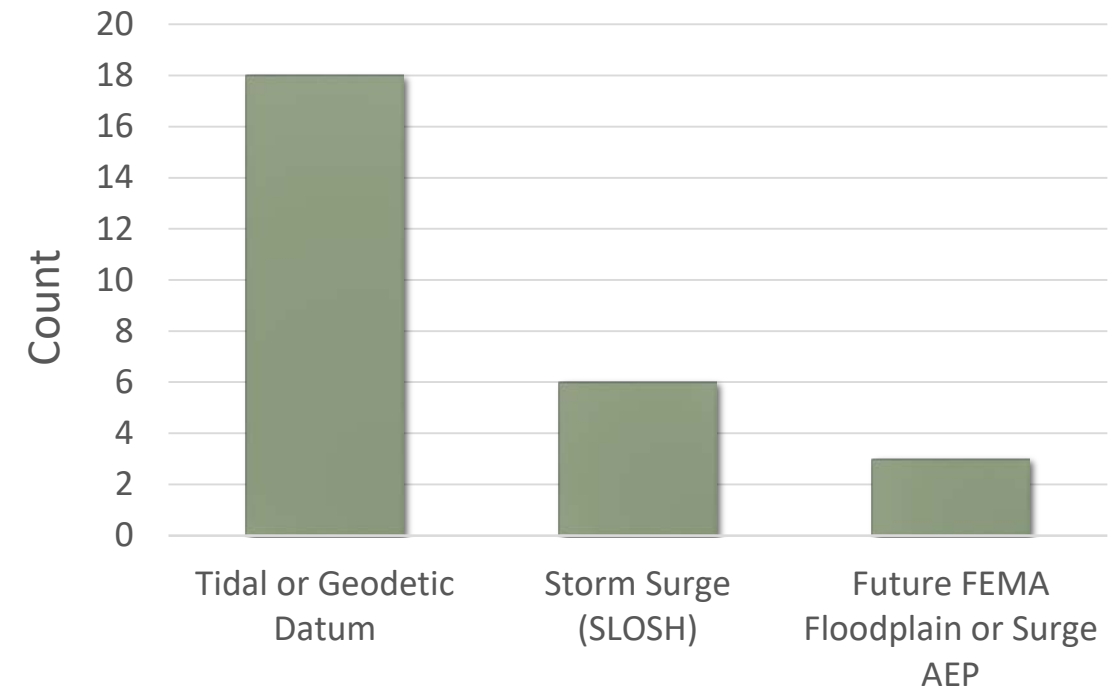
Non-linear surge response

Mapping Products

Looking outwards – what products are out there?
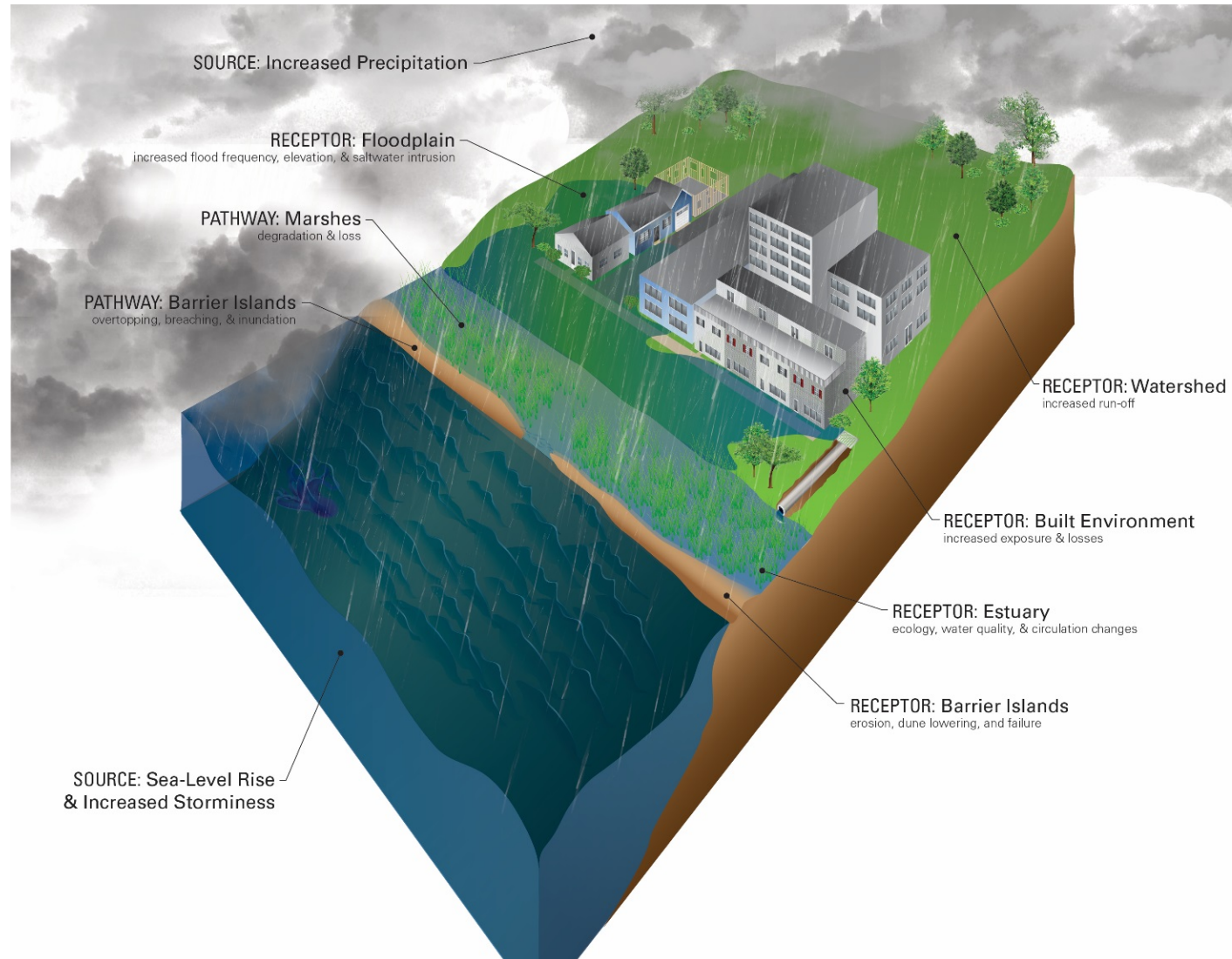
What is being mapped?
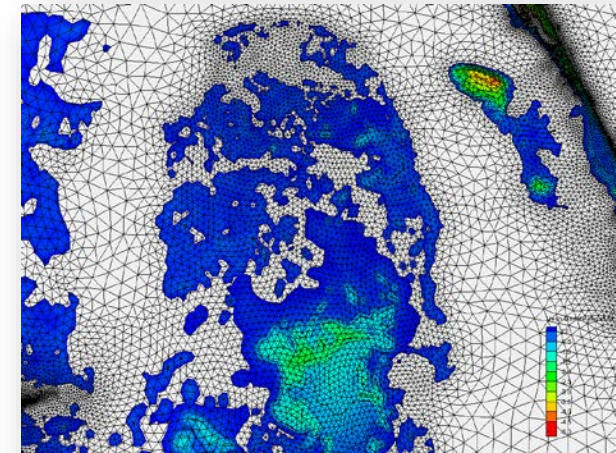

Base Water Level for SLR Maps

It's all inter-related…

Modeling focus areas
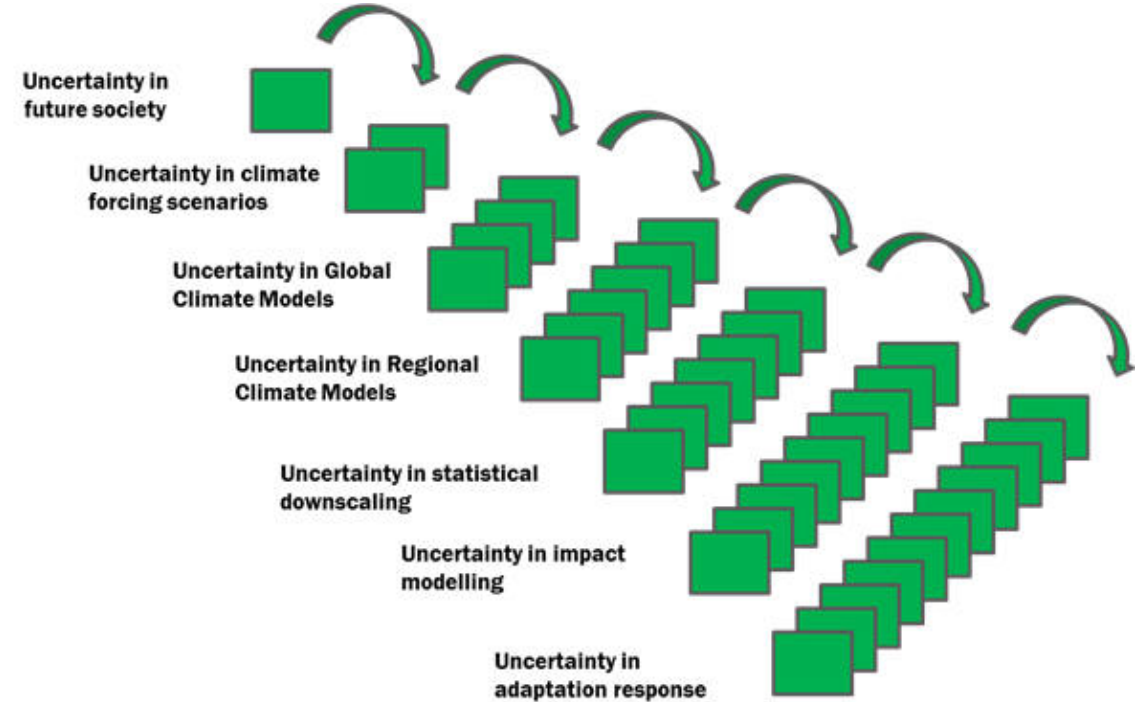
- Holistic representation through *entire* hazard modeling process and map products, where feasible

- Site future pilots to leverage available products
  - i.e., where SLAMM available or other research activities completed or ongoing

- Consider both episodic and long-term erosion in surge modeling

- If not feasible, recognize uncertainty through documentation or error bounds in products

But, if you bite off too much…

Uncertainty in future society

Uncertainty in climate forcing scenarios

Uncertainty in Global Climate Models

Uncertainty in Regional Climate Models

Uncertainty in statistical downscaling

Uncertainty in impact modelling
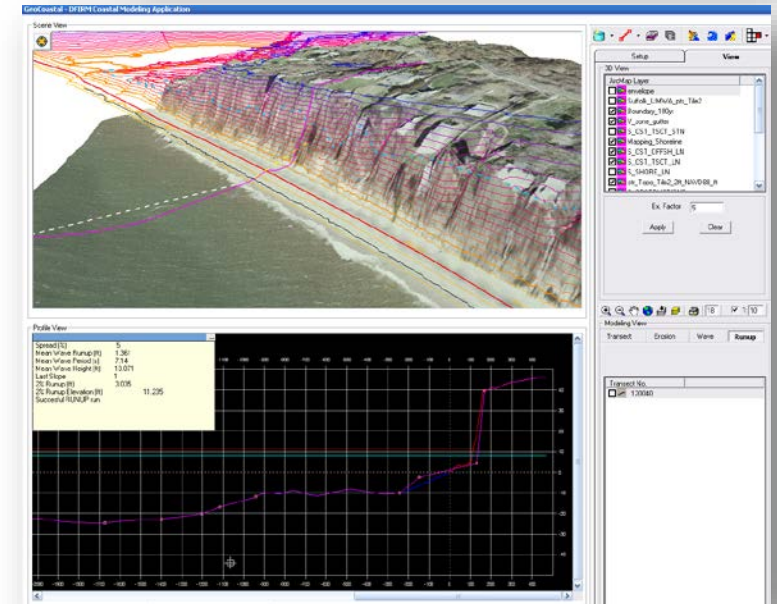
Uncertainty in adaptation response

http://www.riskchange.dhigroup.com/

What about the Wave Runup?

- How important is it?

- Many methods – how sensitive are they?

- Urban areas w/ overtopping, i.e., NYC.

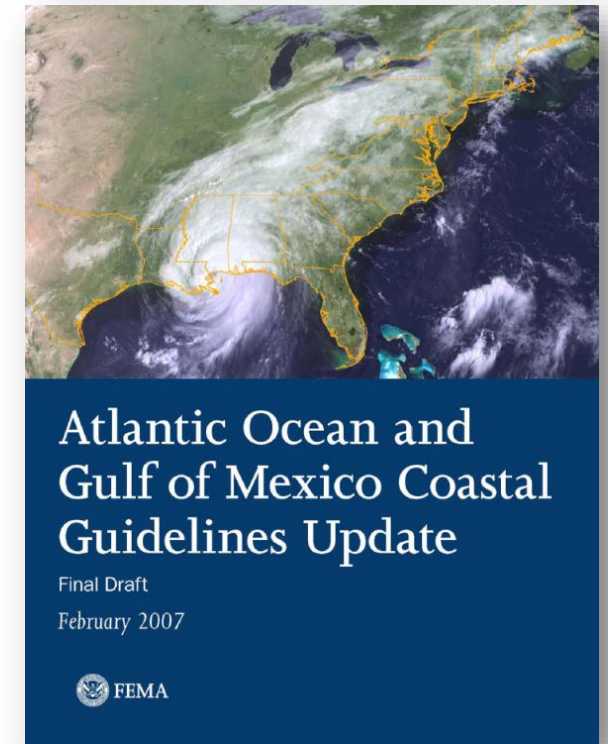- Weigh need to model, coast type and elevation = guidance

Is there need for guidance?

STARR II Strategic Alliance for Risk Reduction

- **<u>Yes!</u>**
- We can leverage completed work to cover:
  - Scenario selection
  - Community input
  - When modeling needed vs. linear superposition
  - Decision-tree to help scope studies
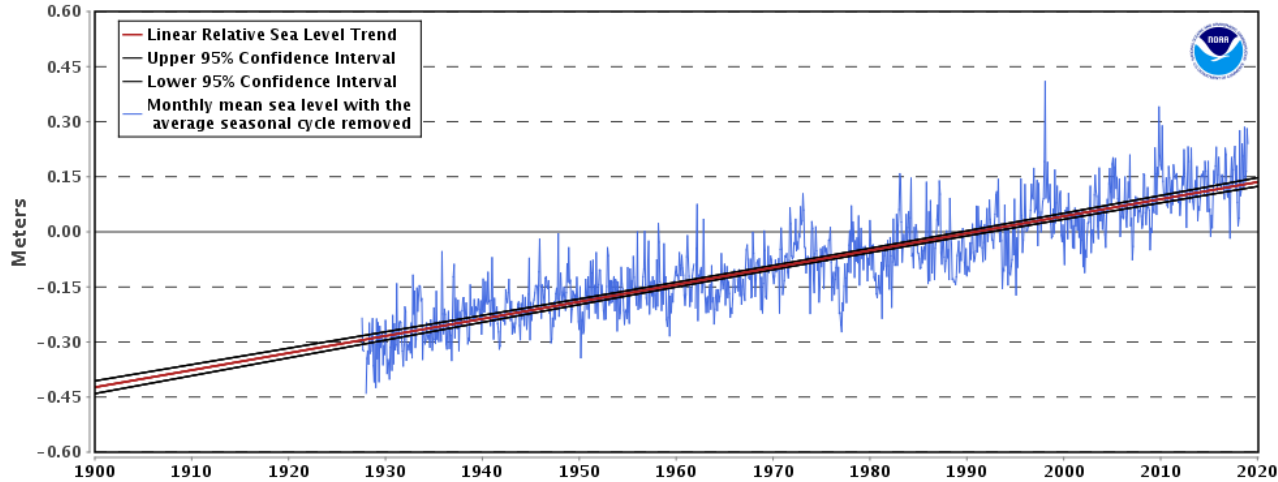 - Product standards
  - Uncertainty

Atlantic Ocean and Gulf of Mexico Coastal Guidelines Update

Final Draft

February 2007

FEMA

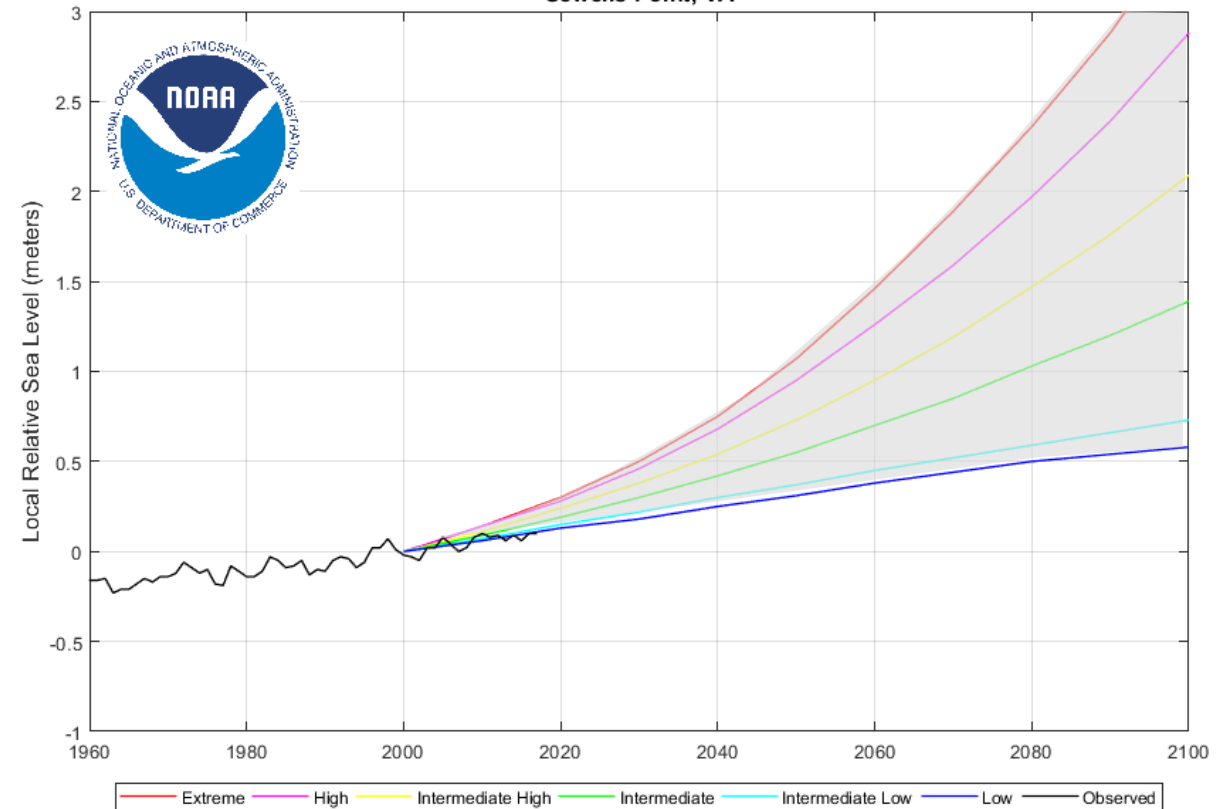# From the established past to an uncertain future

Sewells Point, VA

Relative Sea Level Trend
8638610 Sewells Point, Virginia
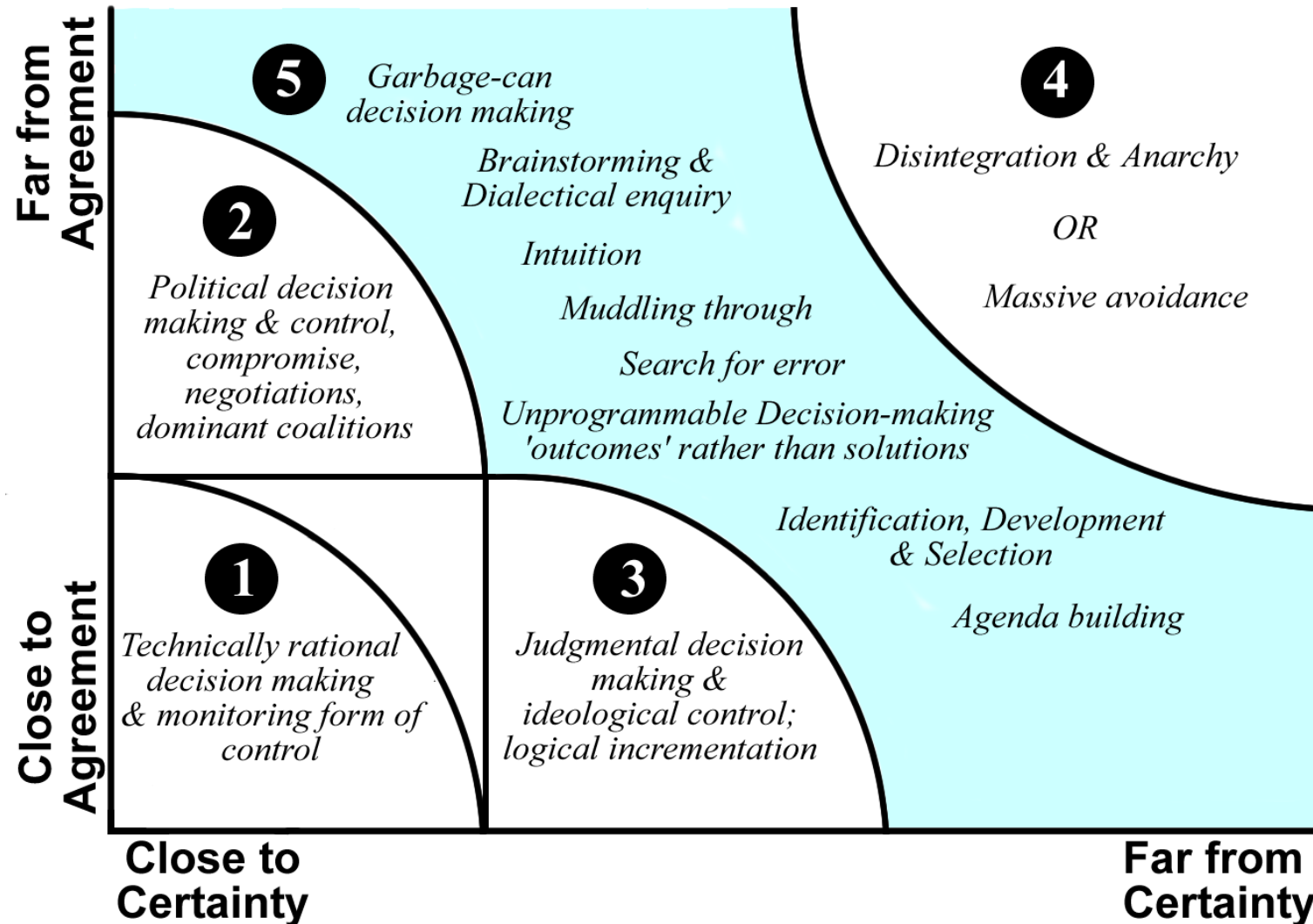
8638610 Sewells Point, Virginia   4.66 +/- 0.22 mm/yr

Outcomes of uncertainty
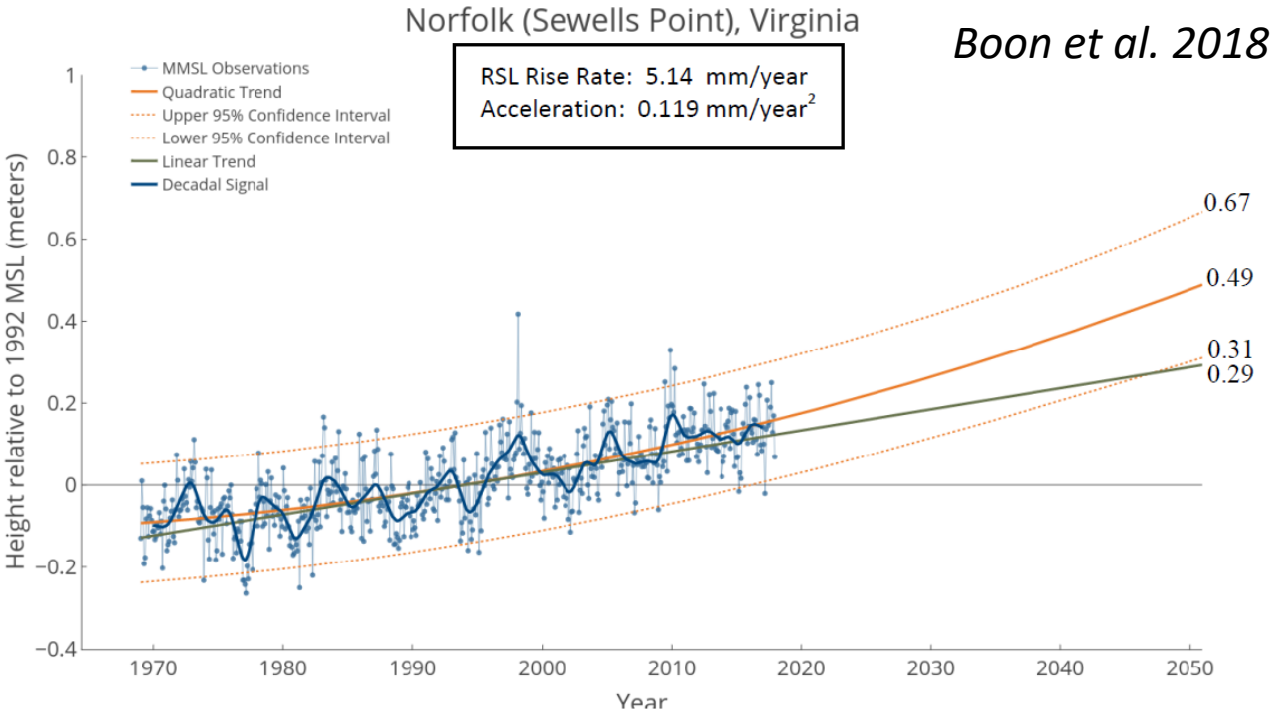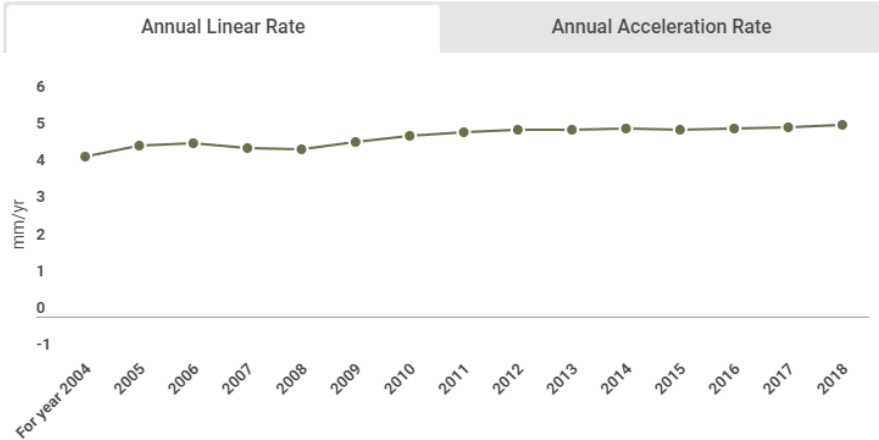

Ralph Stacey
Complexity Matrix

"Empirical" data…

Boon et al. 2018

Figure III-4. Relative sea level trends, Norfolk, Virginia, 1969-2017 series

How to handle scenarios?

Scenario Selection:

- Develop a consistent approach or protocol for selection

  - Minimum standards?

  - Top down, bottom up?

  - Appropriate level of community input and engagement, flexibility to encourage recognition and use for risk reduction?

  - Need both near and long-term time horizons to accommodate resilient comprehensive and infrastructure planning

- Coordination needed across FEMA program areas

  - CRS issuing a minimum standard, too rigid or more flexibility needed across program?

  - Program should have consistency

Taylor & Francis
Taylor & Francis Group

COASTAL MANAGEMENT

Coastal Management

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Rising Sea Levels: Helping Decision-Makers Confront the Inevitable

John A. Hall, Christopher P. Weaver, Jayantha Obeysekera, Mark Crowell, Radley M. Horton, Robert E. Kopp, John Marburger, Douglas C. Marcy, Adam Parris, William V. Sweet, William C. Veatch & Kathleen D. White

To cite this article: John A. Hall, Christopher P. Weaver, Jayantha Obeysekera, Mark Crowell, Radley M. Horton, Robert E. Kopp, John Marburger, Douglas C. Marcy, Adam Parris, William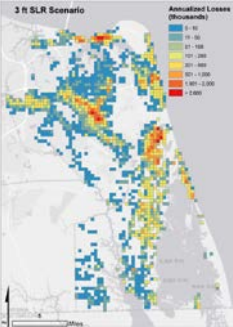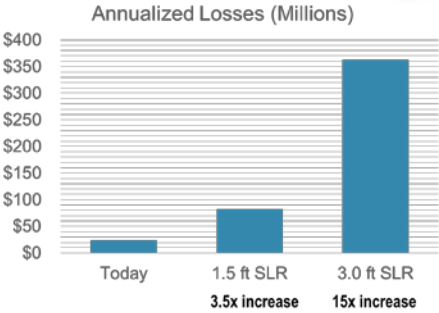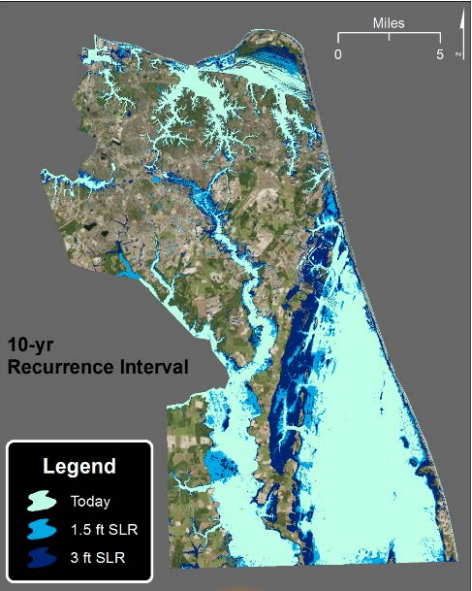 V. Sweet, William C. Veatch & Kathleen D. White (2019): Rising Sea Levels: Helping Decision-Makers Confront the Inevitable, Coastal Management

To link to this article: https://doi.org/10.1080/08920753.2019.1551012

Where does this all leave us?

How Can Future Condition Maps Make a Difference?

STARR II — Strategic Alliance for Risk Reduction

10-yr Recurrence Interval

Legend
- Today
- 1.5 ft SLR
- 3 ft SLR

Annualized Losses (Millions)

Today	
1.5 ft SLR	3.5x increase
3.0 ft SLR	15x increase

3 ft SLR Scenario — Annualized Losses (thousands)

April 21, 2018

City Says "No" to Development Because of Flood Risk - First of a Kind!

flooding issues, stormwater solutions, adaptation actions

Road Near Proposed Development - Virginian Pilot/Ron Stubbins photo

For the first time that we can find, a local government has said "no" to a development proposal due to flood risk. The City of Virginia Beach, hammered by increasing rainfall, has been more sensitive to the flooding potential, especially in the low-lying southern part of the City. But lots of localities are concerned about and planning for flooding, but still

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Judge rules Virginia Beach council can factor in sea level rise when deciding on new developments

By Peter Coutu
Staff writer
Apr 24, 2019

The Virginian-Pilot

LET'S TALK

ICYMI: TOP STORIES

1. A local ice cream boom is coming to Virginia Beach, with 3 new parlors set to open
2. "Pharrell brought his magic:" Something in the Water saw no violent crime, police say
3. A year after Farm Fresh closure, Norfolk looks to bring Piggly Wiggly to "food desert" of Berkley
4. Shake Shack to open in Virginia Beach next week
5. Virginia Beach man admits forcing dementia patient into room and "kissing" her

Courtesy of Ron Stubbins
Virginia Beach City Council will decide Tuesday night if a developer can build a new neighborhood off Princess Anne Road near the intersection of Fenwick Way. The road is known to flood, and is sometimes impassable, as seen in this October 2016 photo.

TODAY'S PAPER

ePilot

Questions?