Evaluation of Analytical Techniques for Production of a Sea Level Rise Advisory Mapping Layer for the National Flood Insurance Program

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Overview

- Background
- Vision
- Study Purpose and Results
- Next Steps

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Background

- FEMA & Climate Change
  - 1991 - Projected Impact of RSLR on NFIP
  - 2007 - GAO recommended FEMA analyze impacts of climate change on NFIP
    - FEMA National Climate Change Study
  - 2010 - SLR Advisory Feasibility Study
- Risk MAP
  - Significant investment into updating coastal studies

Vision for a SLR Advisory Layer

- Non-regulatory (advisory)
- Low incremental production cost
- Develop as add-on to Risk MAP studies
  - Leverage models/data produced by FIS
- Convey future changes to coastal flood hazard
- Guide long-term planning & adaptation
- Develop for pro-active communities

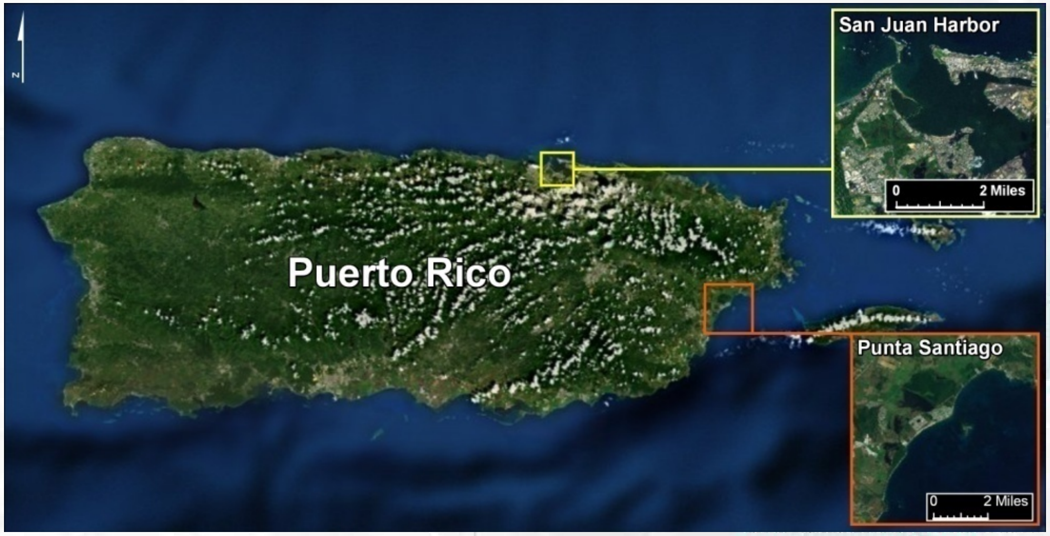
Proof of Concept Study

- Scope:
  - Evaluate analytical techniques for suitability to produce a Sea Level Rise Advisory Layer
  - Consider approaches across the range accuracy and level of effort
  - Evaluate trade-offs
  - Provide mock-ups of cartographic products for advisory layer
  - Recommendations and considerations for follow-on pilot studies

Study Area

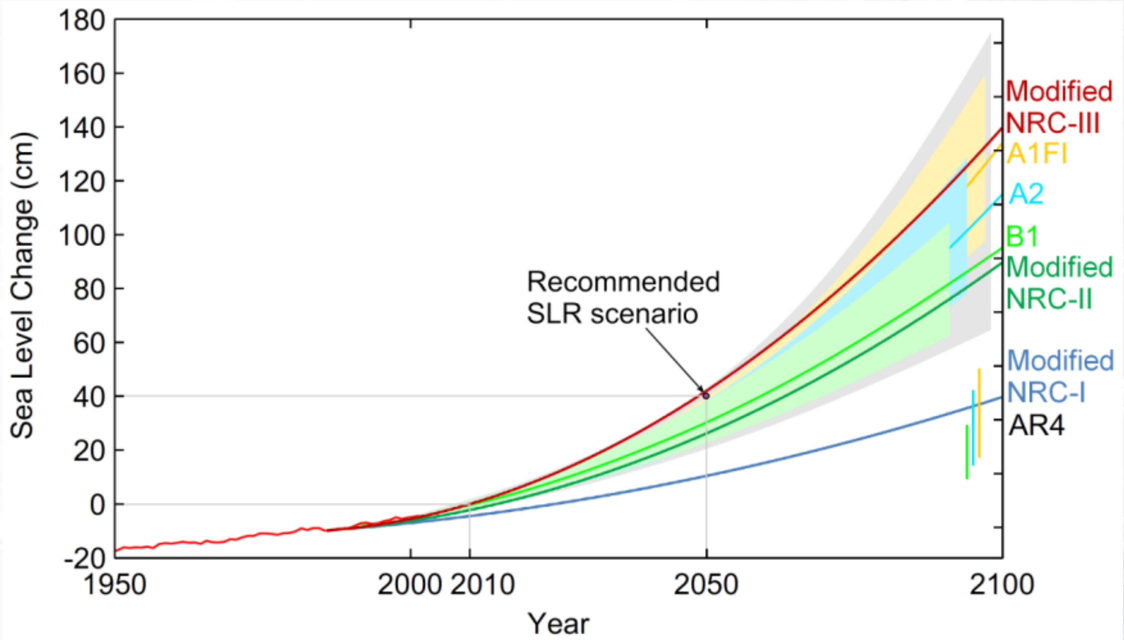
Puerto Rico

- Selection based on ready availability of baseline framework
  - o **Ability to cost effectively re-run FIS analysis**
  - o Accessible data
  - o Modern study*
  - o Diversity of coast type



Sea Level Rise Scenario Definition for This Study

- Methodology
  - Review latest literature
  - Evaluate observations
  - USACE procedure (EC 1165-2-211)
  - Validate selection
- Scenario:
  - Limited to 1
  - 0.4 m (1.3 ft) @ 2050



Adapted from Vermeer & Rahmstorf, 2009, and USACE, 2009

Methodologies

Process:

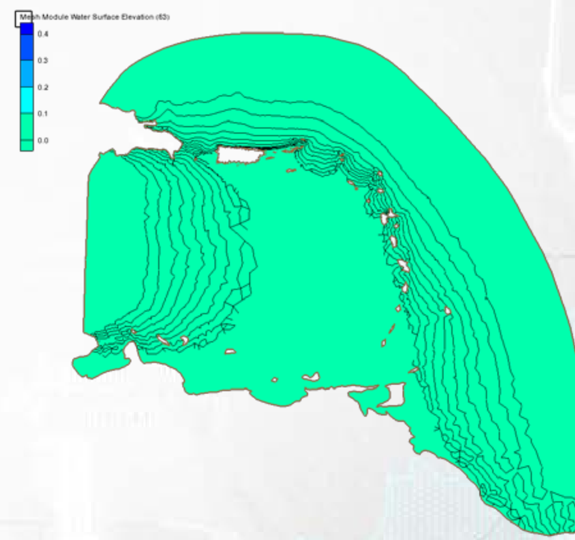
1. Establish Baseline
2. Evaluate Proposed Combinations
3. Compare Results

Methods:

		Wave		
		WHAFIS	HAZUS FIT	Wave Equations
Surge	ADCIRC	Baseline		
	SLOSH		X	
	Linear Superposition	X	X	X

Storm Surge Modeling - ADCIRC

- ADCIRC Simulations
  - Approach
    - Re-use FIS model, input files, storm suite
    - Impose SLR condition at boundaries, wait & save
    - Run storms on new condition, same setting as FIS
  - Issues
    - New instabilities



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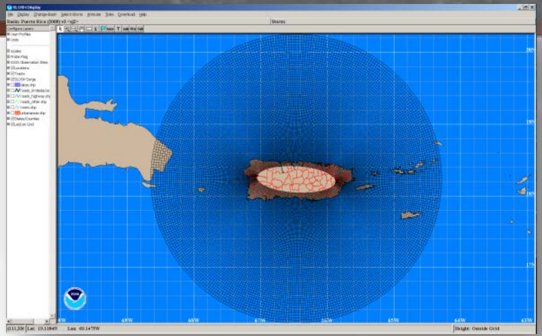
Storm Surge Modeling - SLOSH



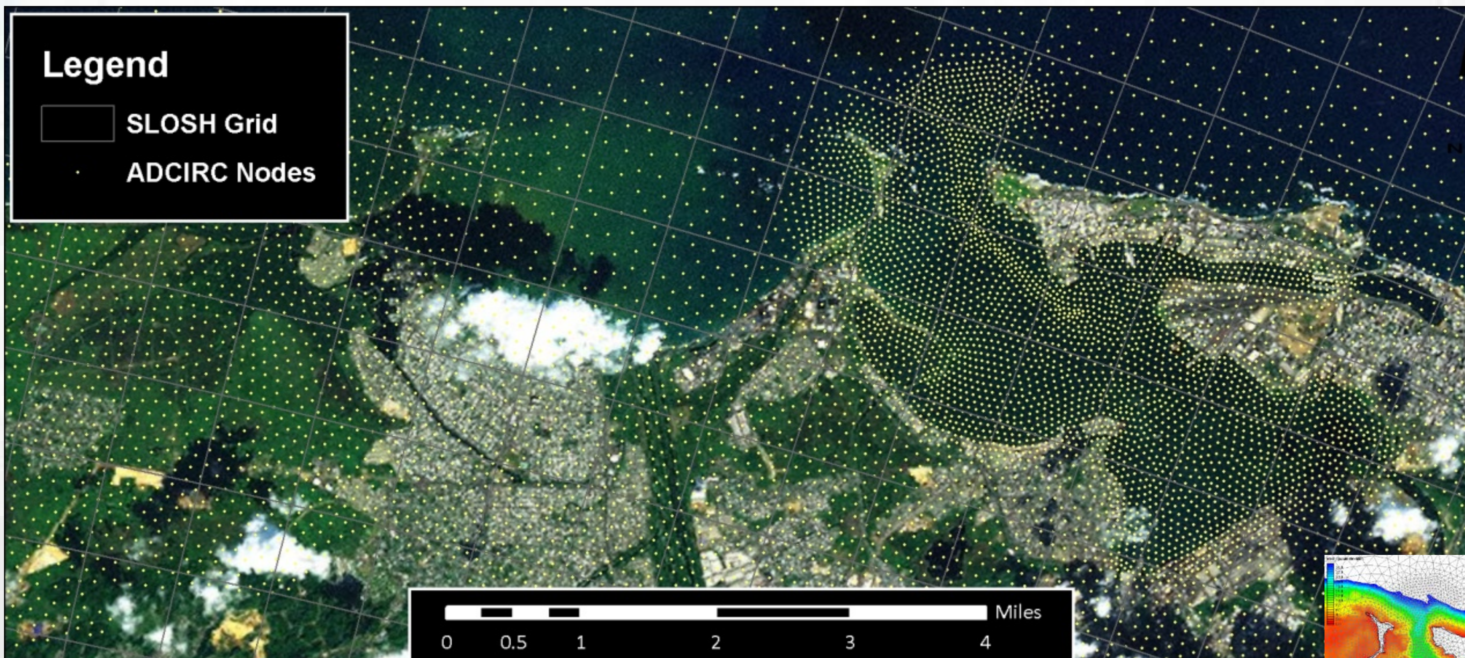
- SLOSH Simulations
  - Approach
    - Leverage National Hurricane Center Basin (2010)
    - Re-use FIS storm data, surge stations
    - MSL, then set SLR condition as tide level
  - Issues
    - Weather generated, rather than input
    - FIS surge stations too dense, req. adjustment

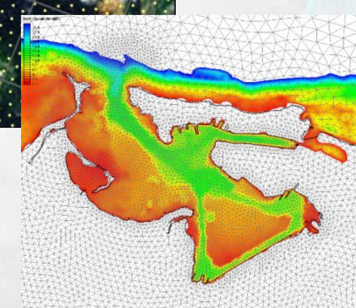
Comparison – ADCIRC & SLOSH

At coast:

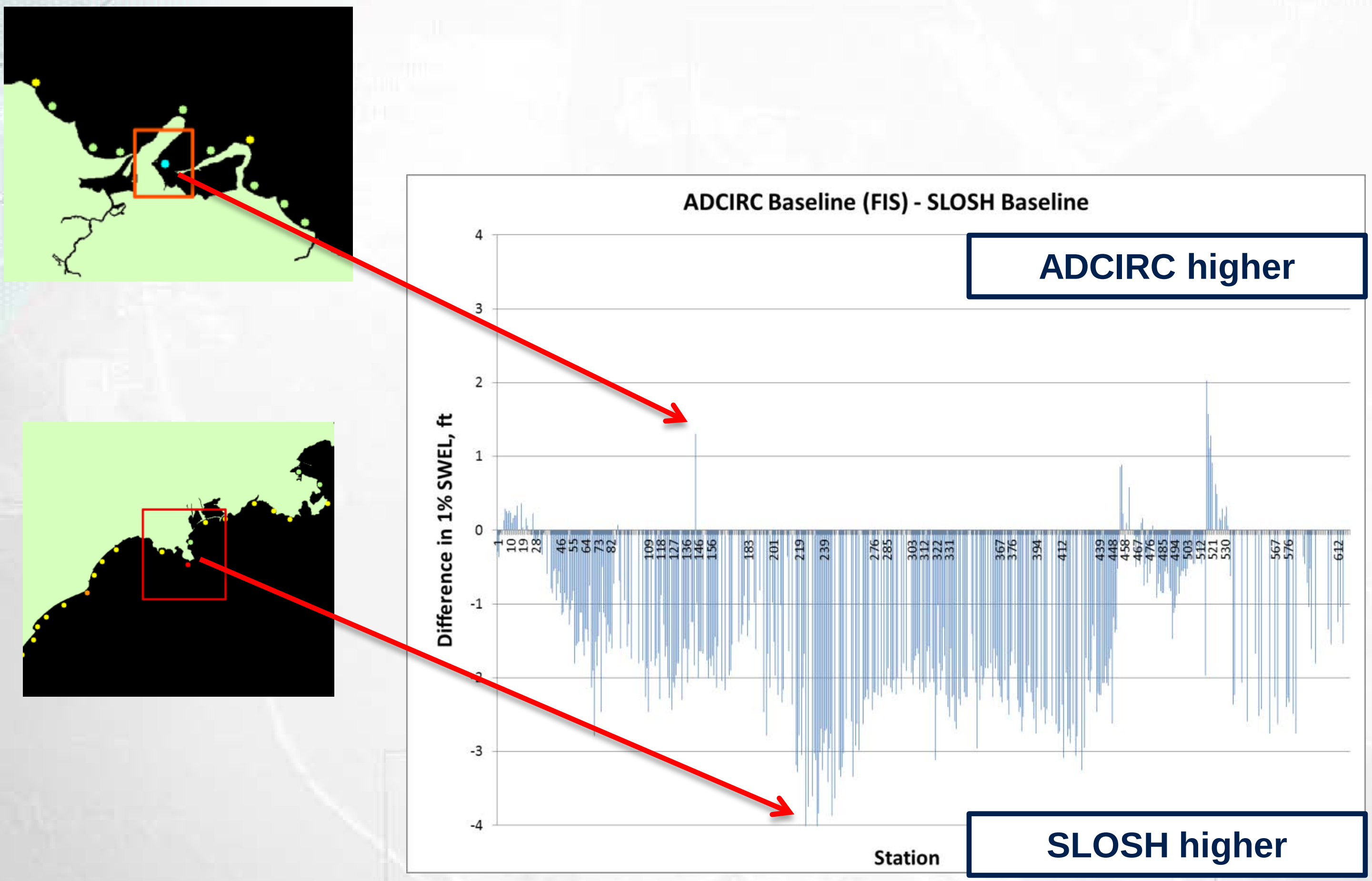
SLOSH: 0.5 mi (2580 ft)

ADCIRC: 250-550 ft





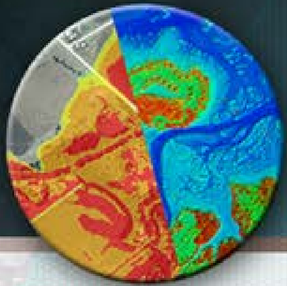
ADCIRC Compared to SLOSH (FIS Case – 0 ft MSL)



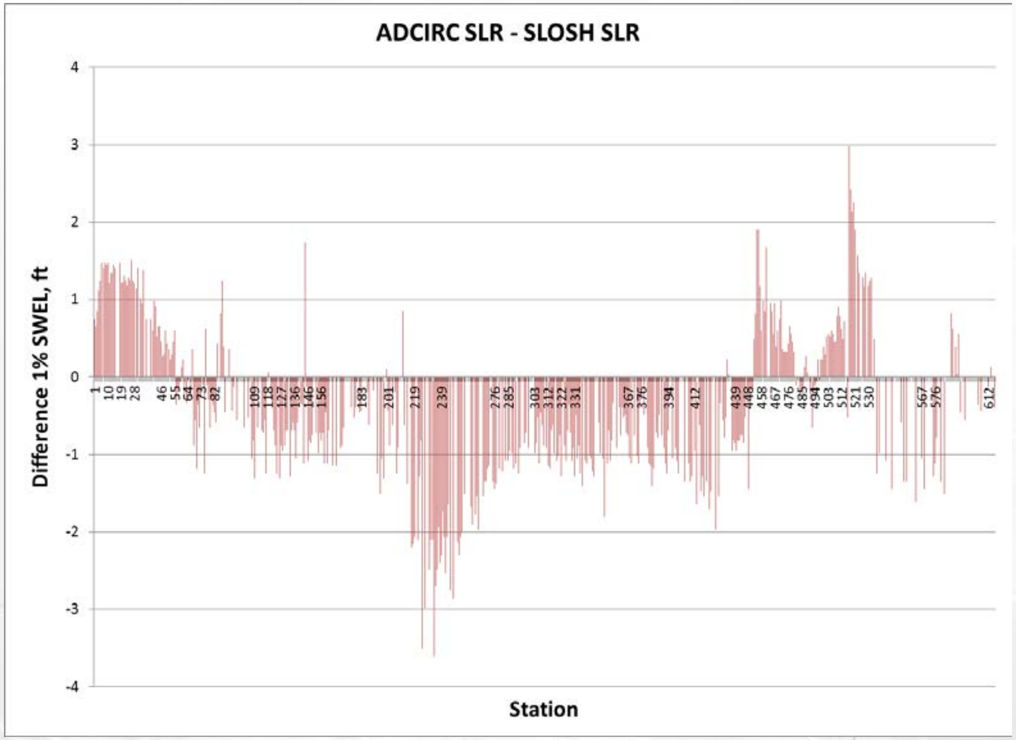
SLOSH > FIS (ADCIRC)

Median: 1.7 ft
Range: 6.4 ft
23% Error

Trend: Difference ↑ w/ return period.
(1.3 ft spread from 10 to 500 yr)



ADCIRC Compared to SLOSH (SLR Case – 1.4 ft MSL)



SLOSH > ADCIRC

Median: 0.6 ft
Range: 6.6 ft
Error: 10%

Previous Trend:
Difference ↑ w/ return period –
Not evident in this case

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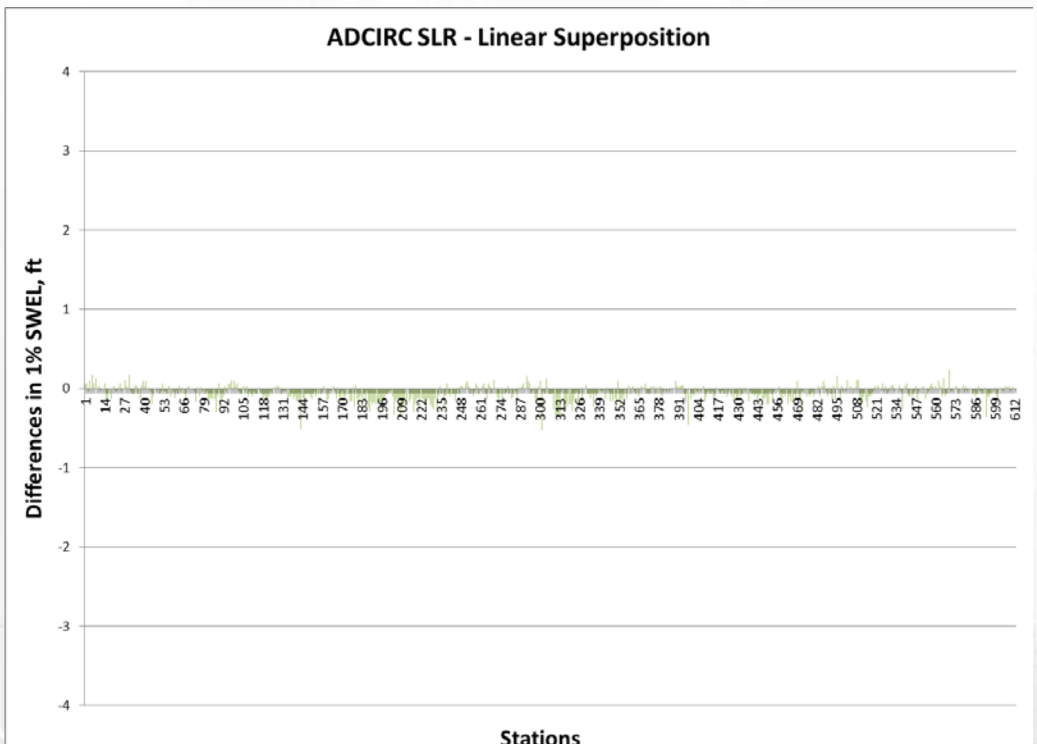
ADCIRC Compared to Linear Superposition (SLR Case - 1.4 ft MSL)



ADCIRC SLR ≈ Simple +

Median: 0 ft
Range: 0.8 ft
Error: 1%

Trend: Difference ↑
w/ return period – (0.1)

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Comparison of Surge Methodologies

Method	Pros	Cons	External Data Requirements	Required Expertise	Duration
ADCIRC	Accurate, consistent with FIS	Expensive	None*	High	2-5 Months**
SLOSH	Quick, physics based	Did not compare well to FIS elevations (Baseline = +23% error; SLR = +10% error)	Some preparation required depending on study	High	2 Weeks
Linear Superposition	Simple and efficient, compared well to ADCIRC solution	Does not directly consider physical process, applicability to other locations uncertain (1% error)	None	Low	1 Hour

*Assumes ADCIRC application for FIS study

**Represents computational production requirements for typical JPM storm suites

Summary of Wave Hazard Methods

Method	Pros	Cons	External Data Requirements	Required Expertise	Duration
WHAFIS	Spatially variable, considers dune failure, obstructions and wave regeneration	Relatively expensive	None	High	2-6 Weeks*
HAZUS Flood Information Tool	Existing application, seamless implementation	Did not work (tools not implemented)	None	Medium	-
Wave Equations	Informative, effective given uncertainties	No obstructions, not spatially variable	None	Low	1 Hour

*Duration dependent on size and complexity of study area

Application of Wave Equations

- Apply depth-limiting wave criterion to assess changes in flood elevation
- Shows that wave effects can increase flood elevation beyond sea level change

Parameter, all units in feet	Baseline Case		SLR Scenarios		
			1 ft	2 ft	3 ft
Total Stillwater	12		13	14	15
Ground Elevation	5		5	5	5
Water Depth	7		8.0	9.0	10.0
Wave above SWEL	3.8		4.4	4.9	5.5
Wave Crest Elevation	15.8		17.4	18.9	20.6
BFE	16		17	19	21
Difference, SLR-Baseline			1	3	5

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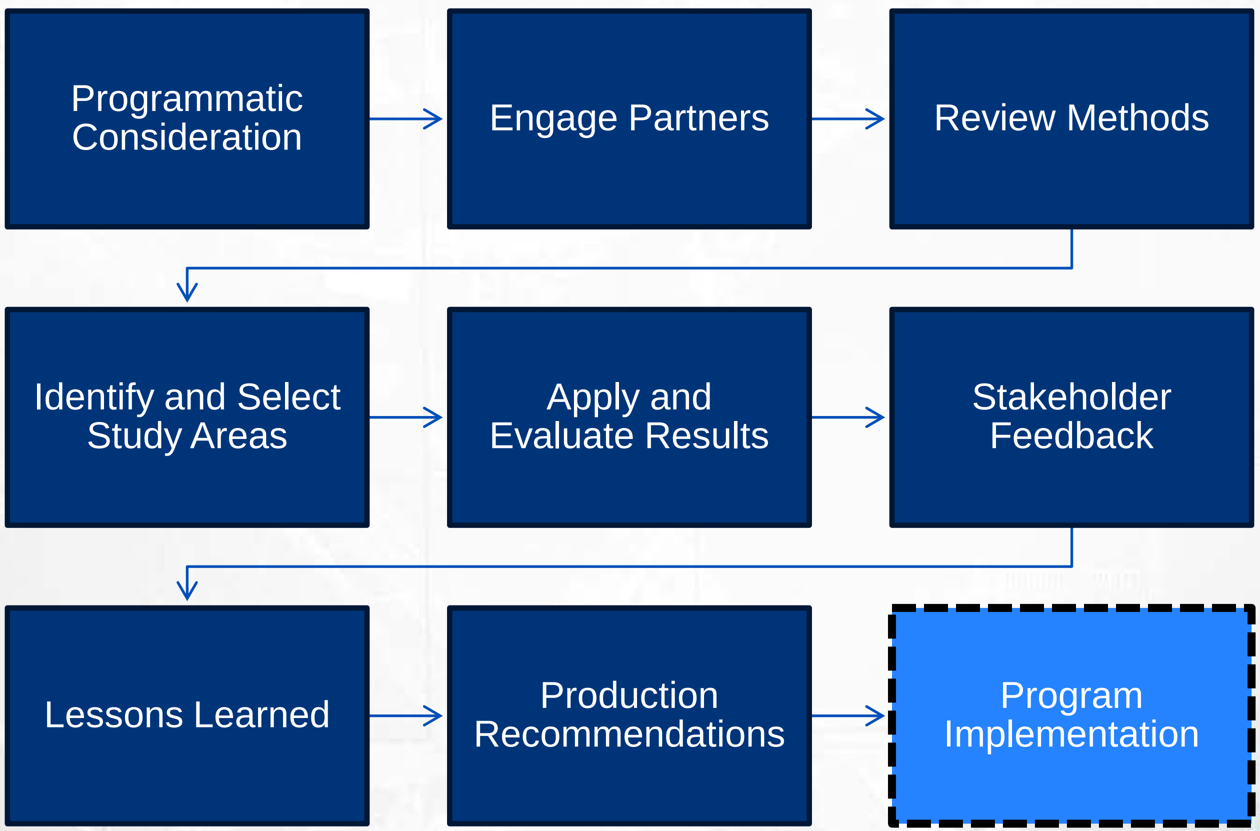
Findings and Recommendations

- Further examination of linear superposition needed
- FIS approach provides only accurate description of changes to flood zone boundaries
- Analysis best undertaken at the time or shortly after FIS studies
- Both changes in surge elevation and wave height should be considered
- Linear superposition combined with wave equations may provide effective estimate at low production cost
- Implement through Community Rating System and Coastal Construction Manual

Next Steps

- Proposed plan for phased approach over FY10-12



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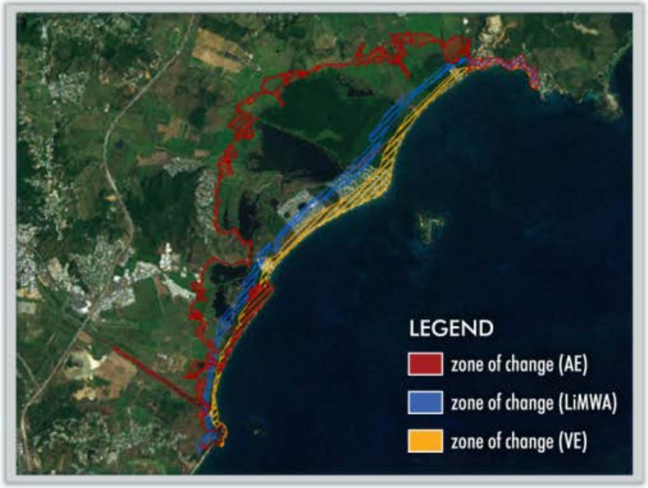
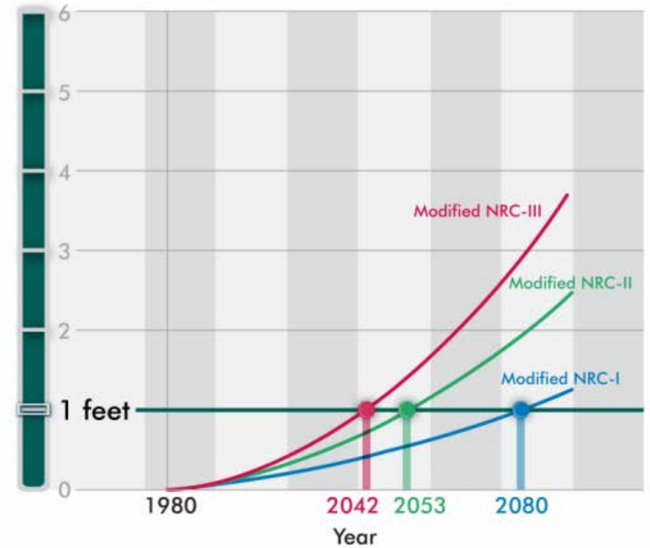
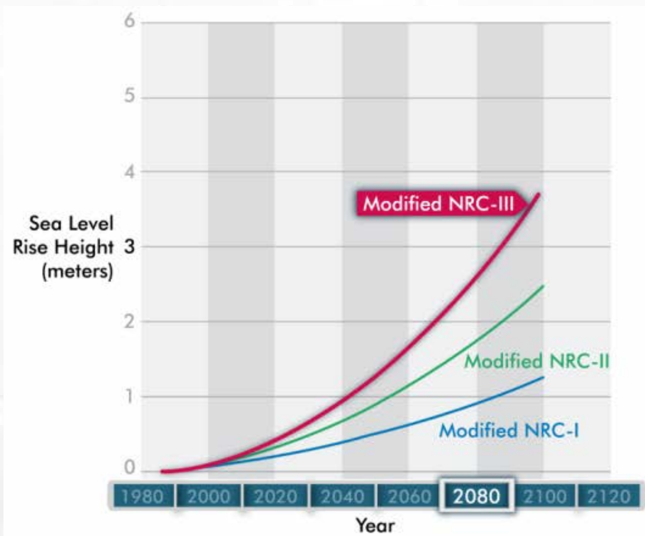
Data Serving Concepts

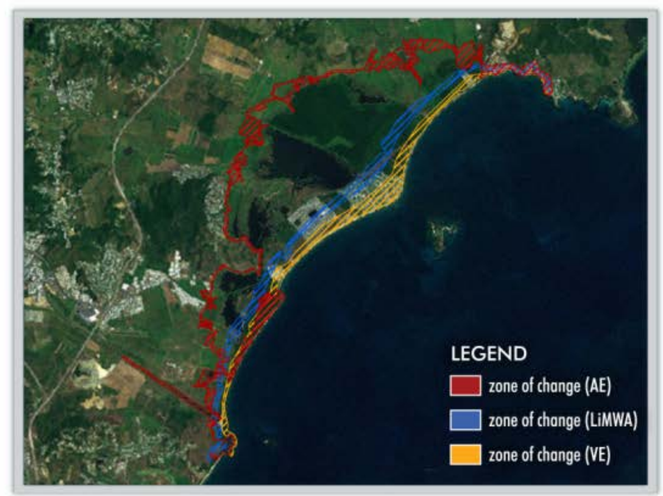
- **Increment Driven**





- **Scenario Driven**





Questions?

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