Quantifying the Benefits of Engineering Adaptations and Nature-Based Solutions on Barrier Island Community Resilience

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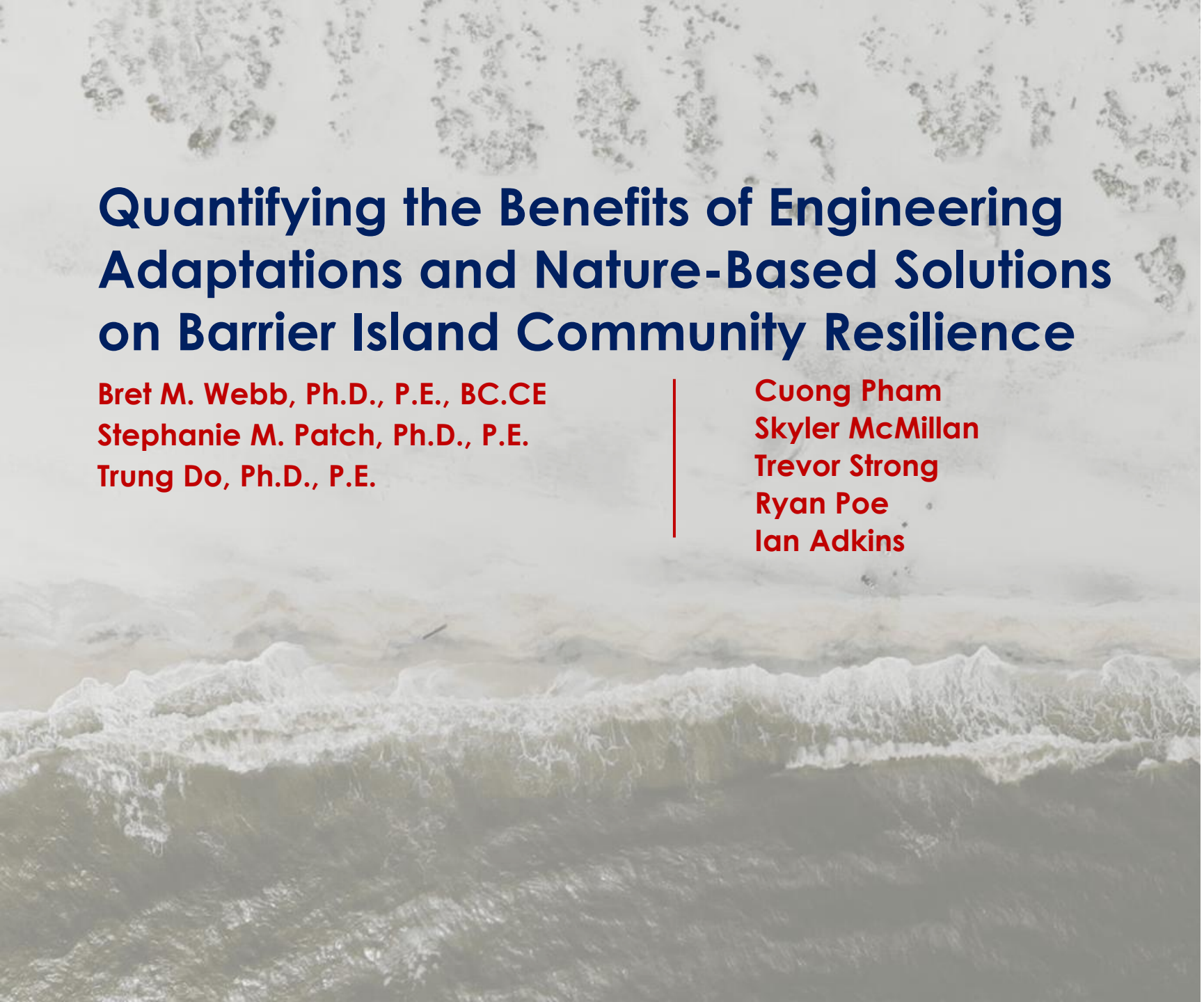

Resilience

USCRP
US COASTAL RESEARCH PROGRAM

ASBPA Best of the Best: Best Restored Beach Award Nominees

Celebrate a century of coastal restoration excellence!
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Florida Nominees

2025 Canaveral Harbor Sand Bypass Project, Brevard County
2023 City of Boca Raton, City of Deerfield Beach and Town of Hillsboro Beach, Florida Joint Nourishment Project
2021 St. Joseph Peninsula Beach Renourishment Project
2021 Upham Beach Stabilization Project
2020 Norriego Point
2019 Duval County
2017 Phipps Ocean Park, Palm Beach
2015 Western Destin Beach
2015 South Hutchinson Island/St. Lucie
2014 Cocoa Beach, Brevard County
2013 Delray Beach
2012 Navarre Beach
2012 Captiva Island
2011 Miami Beach
2010 Navarre Beach
2009 Duval County
2009 Lido Key, Sarasota
2009 St. Joseph Peninsula (Cape San Blas)
2008 North Boca Raton
2008 South Walton & Destin Beaches
2008 Venice Beach
2007 Collier County, FL, Beach Nourishment Program
2006 Captiva Island
2006 Pinellas County Beaches
2005 Indian River County
2002 Delray Beach
2002 Panama City Beach
2002 Pompano Beach/ Lauderdale-by-the-Sea Beach

ASBPA's annual Best Restored Beach Award raises public awareness of the recreational and economic value of restored beaches from coast to coast and the U.S. territories.

Nominate your project for the 2026 Best Restored Beach Award at ASBPA.org!

Scan to Vote at ASBPA.org

Presentation Outline

- Overview
- Approach
- Methods
- Results
- Next Steps

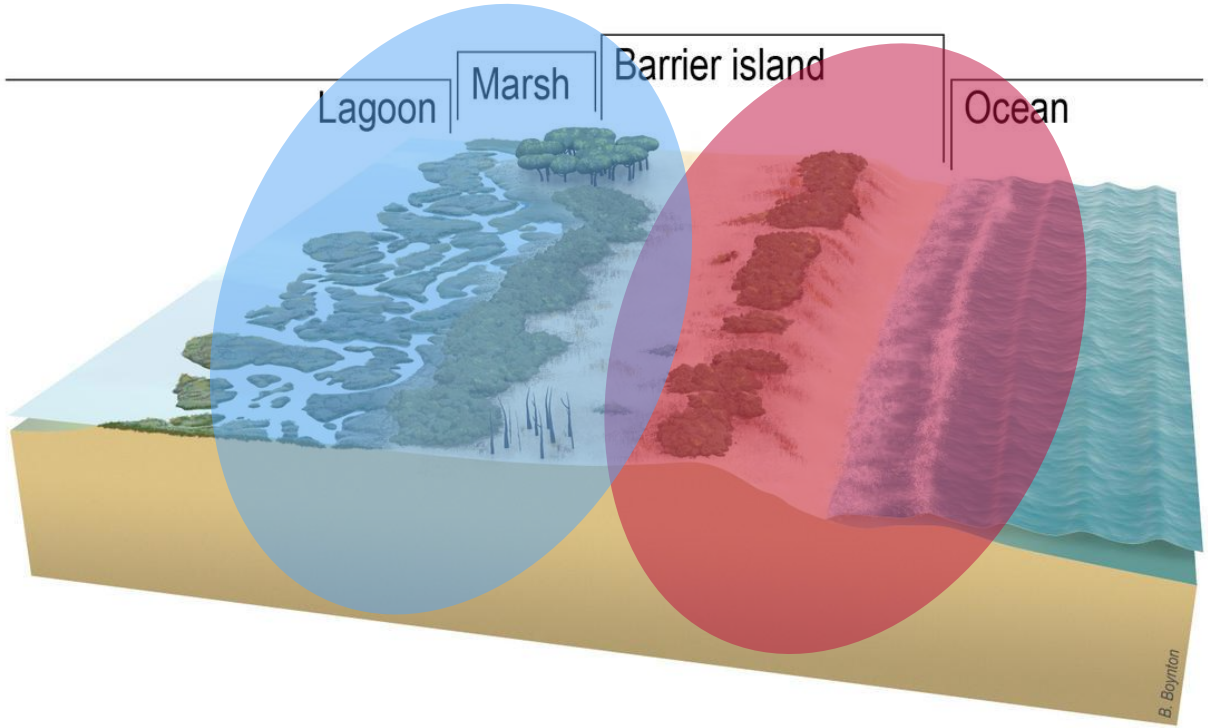
Overview

Overarching Goal

Flood Risk Management (FRM)

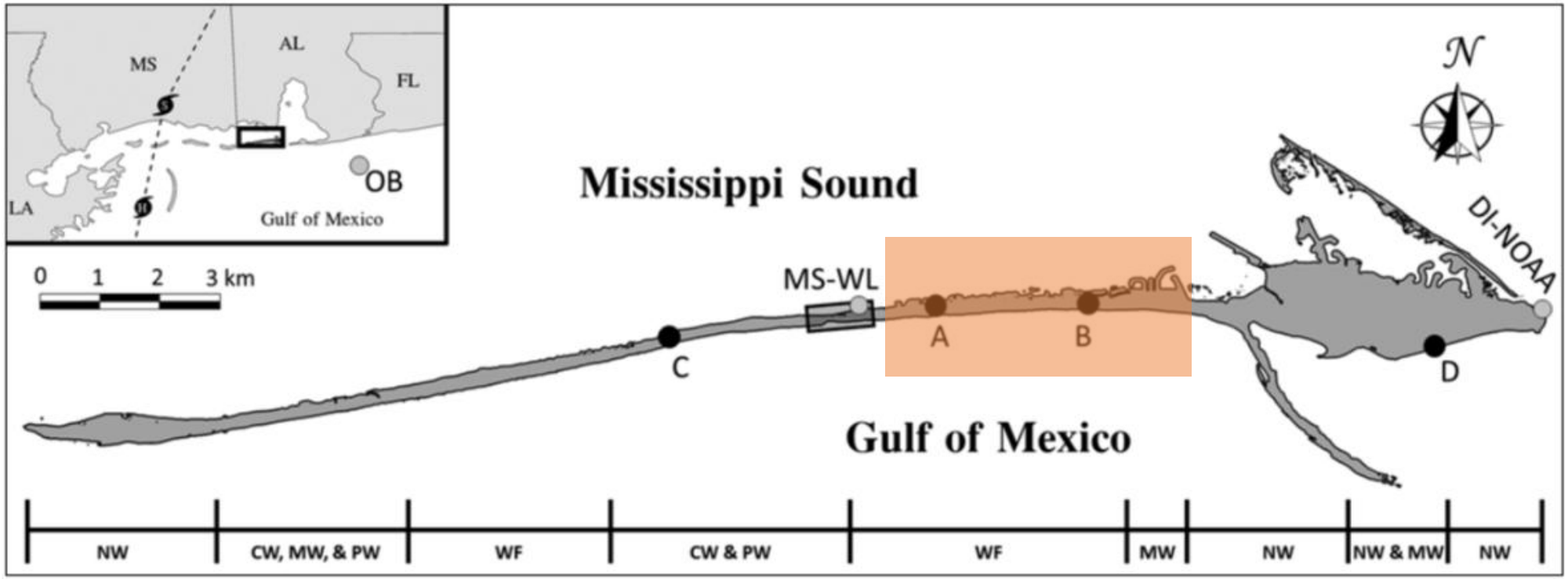
- Beach Nourishment
- Dune Restoration
- Fortification (strength, elev.)

- Back Barrier Resilience
- Cross-Section Management



https://www.usgs.gov/media/images/illustration-describes-barrier-island-ocean-lagoon

Dauphin Island, Alabama



Dauphin Island, Alabama

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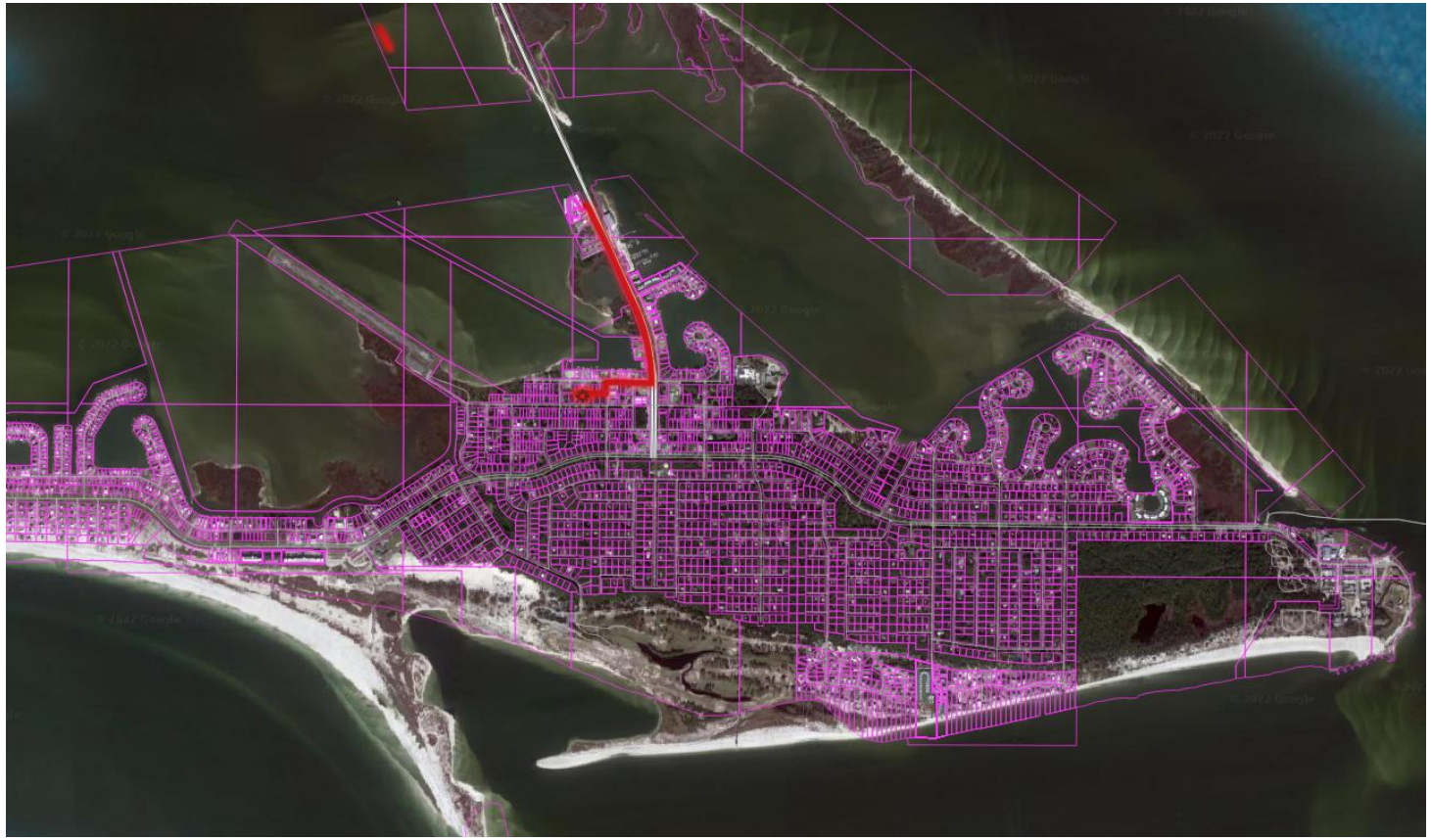
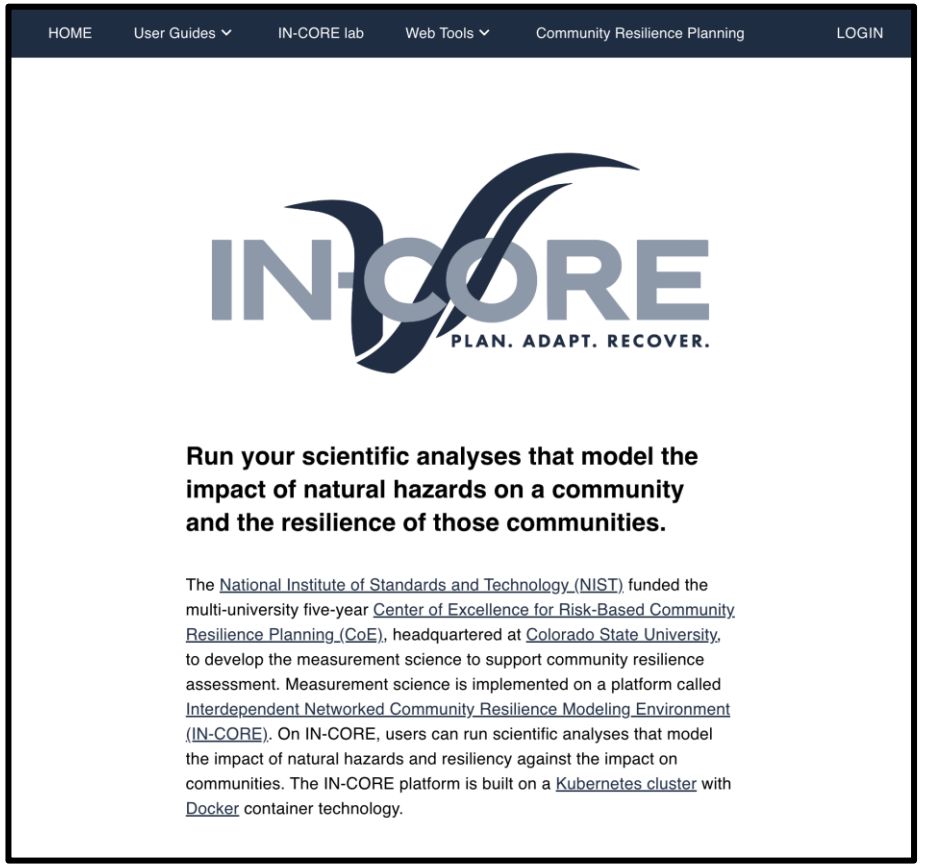
- Parcel Data
- Building Footprints
- Transportation
- Power
- Water
- Sewer
- Critical Facilities



Approach

Approach

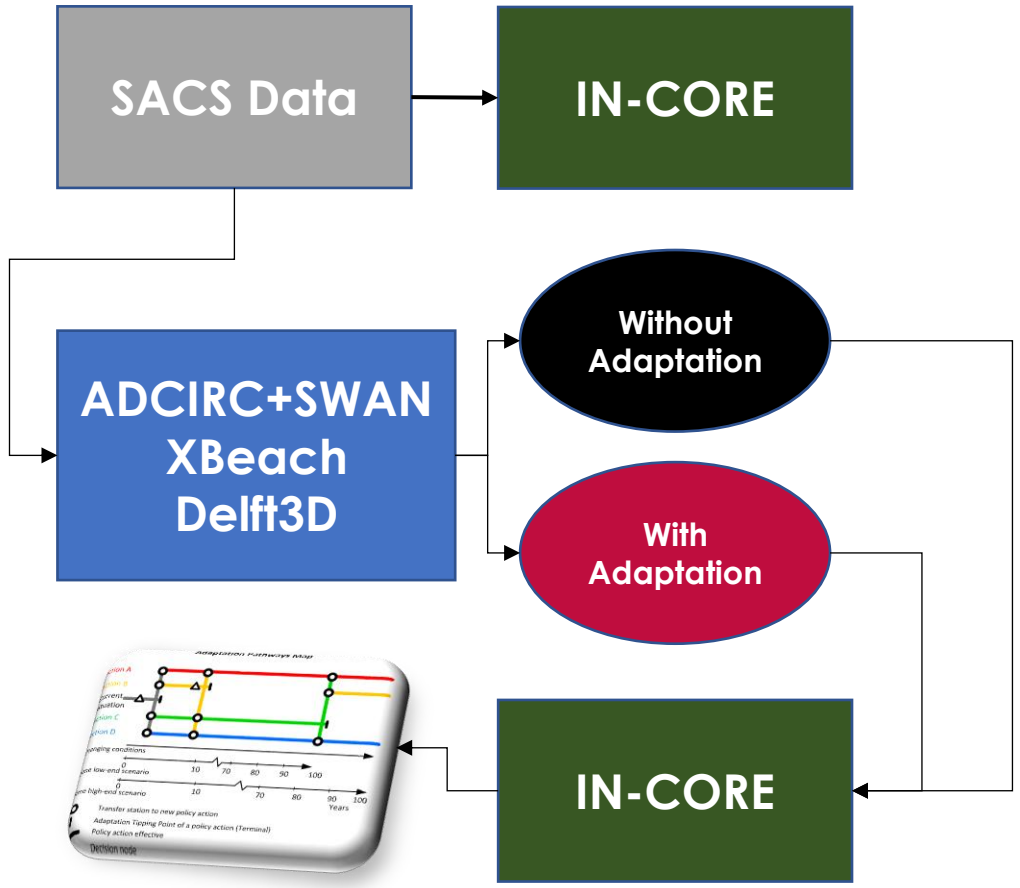
- Analyze Existing Data
- Model Coastal Hazards
  - Existing Conditions
  - Future Conditions
  - With / Without Adaptations
- Model Resilience
  - IN-CORE



https://incore.ncsa.illinois.edu/

Approach

1. Establish Baseline Community Resilience
2. Model Future Flood Risk Hazards
3. Predict Future Community Resilience
4. Create Adaptation Pathways



Methods

1D XBeach Modeling

Extreme Event Scenarios

- Present Day MSL
- 2055 MSL*
- 2085 MSL*
- 1% AEP
- 4% AEP
- 10% AEP

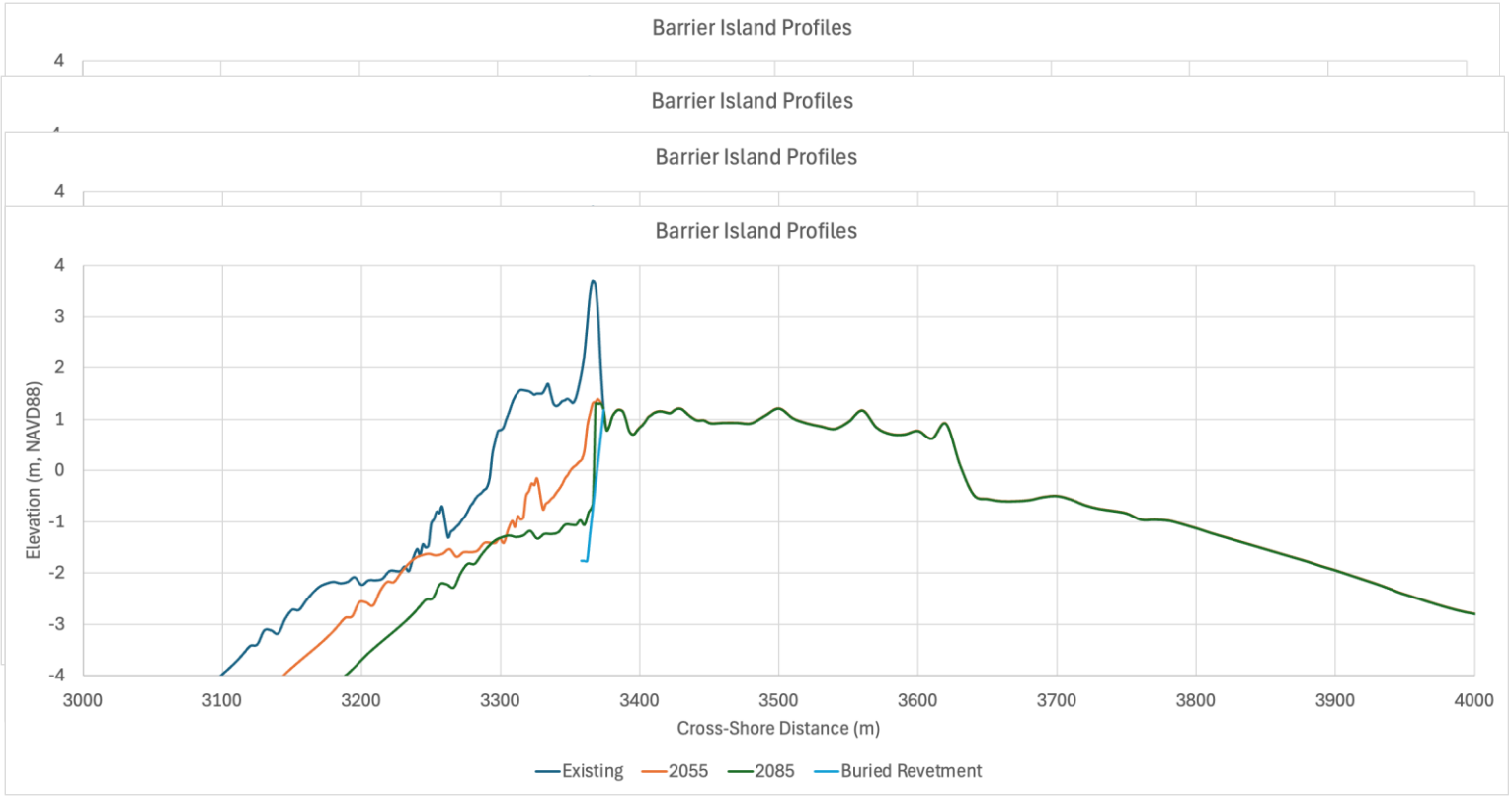
**IPCC AR6 SSP5-8.5 50th Percentile*

Adaptation Scenarios

- Do Nothing
- Beach+Dune Restoration
- Beach+Dune+Island Lift
- Beach+Dune+Lift+Bayside
- Buried Revetment
- Seawall
- Elevate Homes

1D XBeach Modeling

- Background Erosion Rate
  - -1.2 m/yr
- Bruun Rule
  - 2055: -30.7 m
  - 2085: -51.2 m



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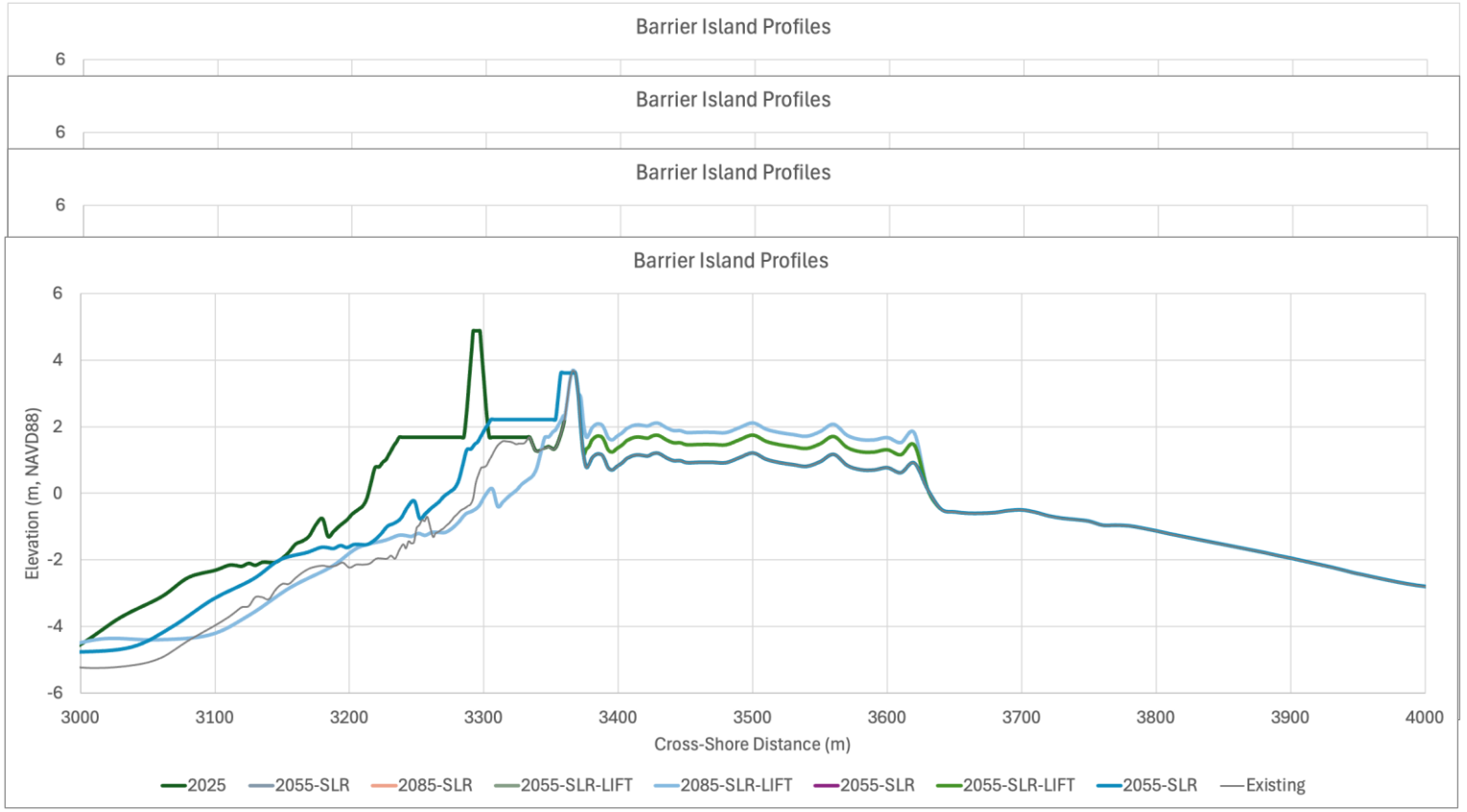
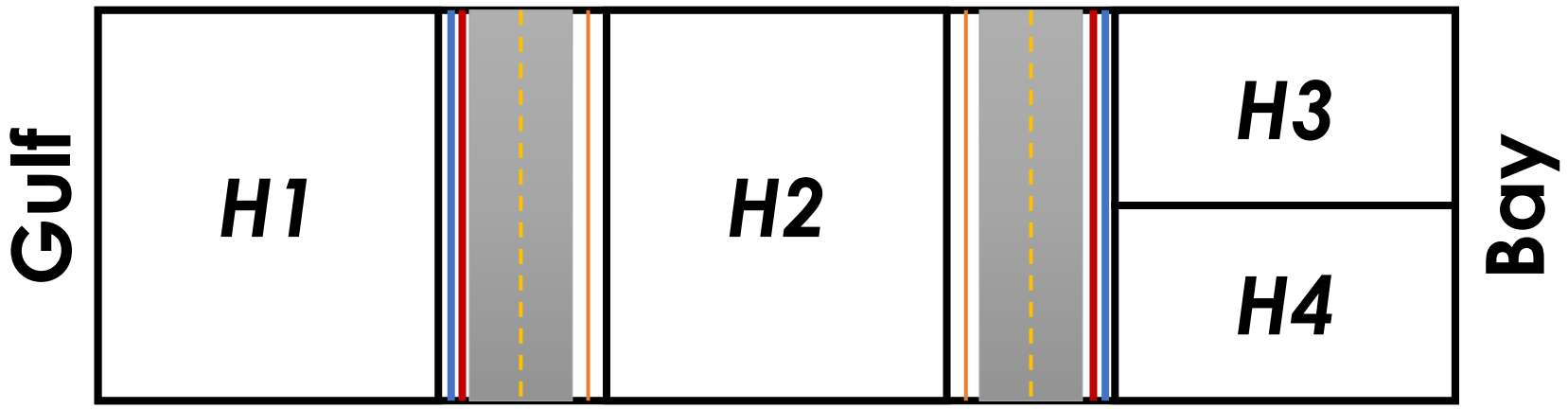


Infrastructure Model

- Homes
- Roads
- Telecoms
- Water
- Sewer



Infrastructure Model

- Homes
- Roads
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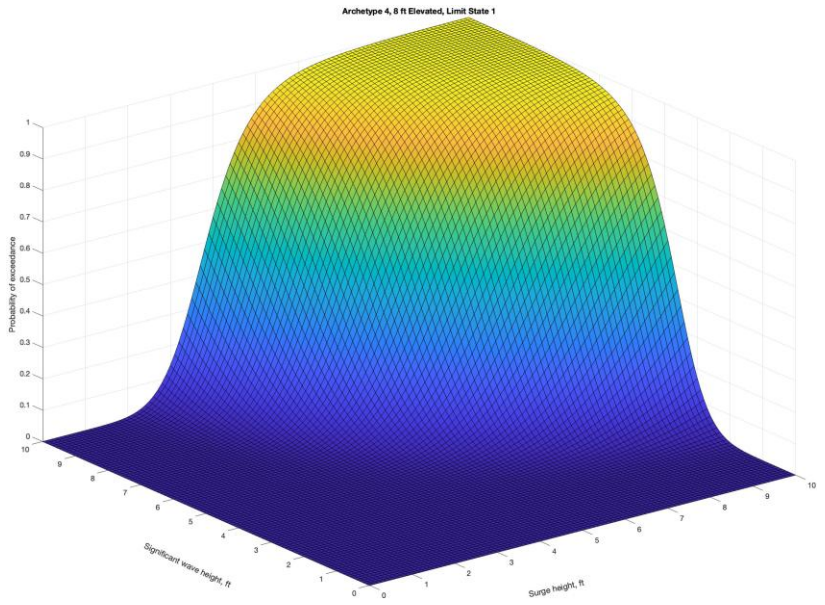
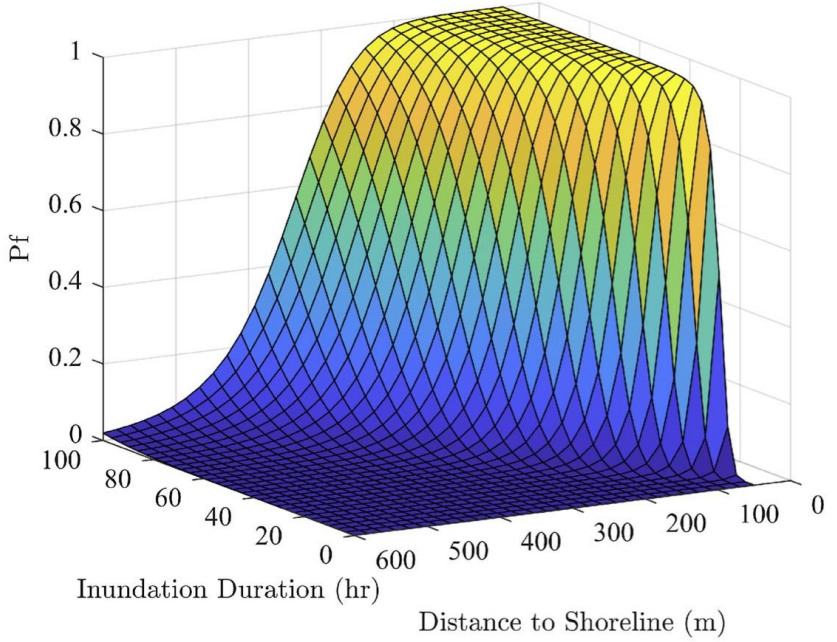
Elevated Structure Fragility



Do et al. (TBD)

Coastal Roadway Fragility



Darestani et al. (2021)

Infrastructure Model

Damage State Classification

DS=1

DS=2

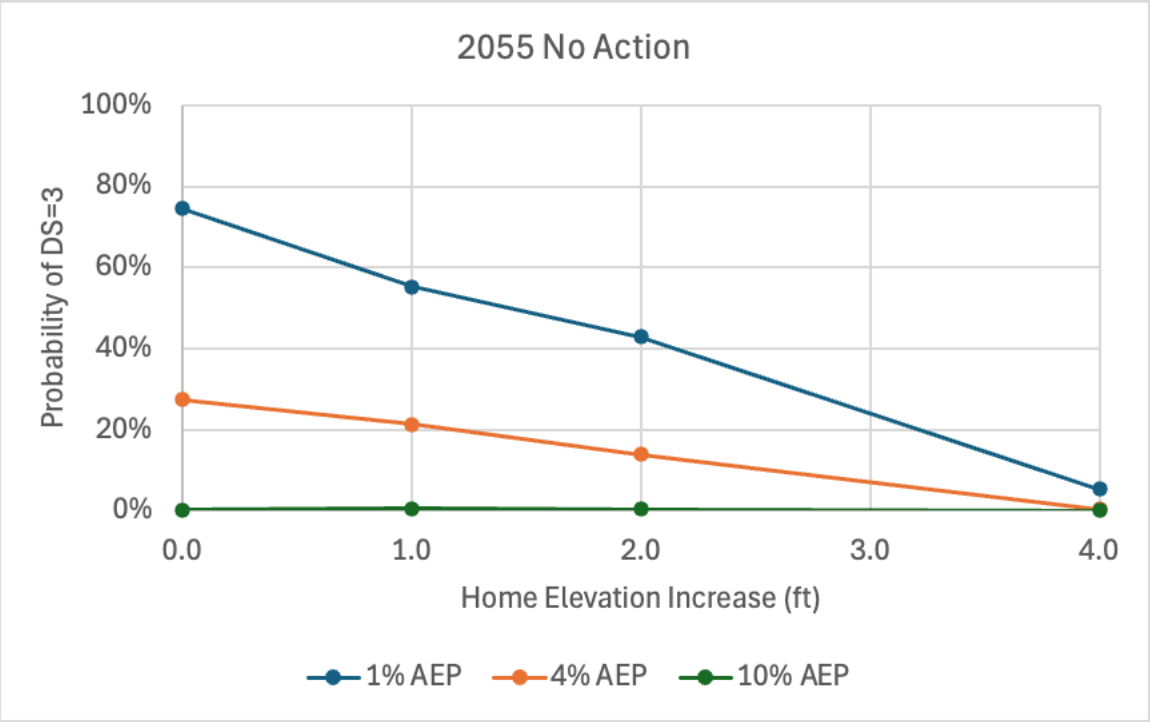
DS=3

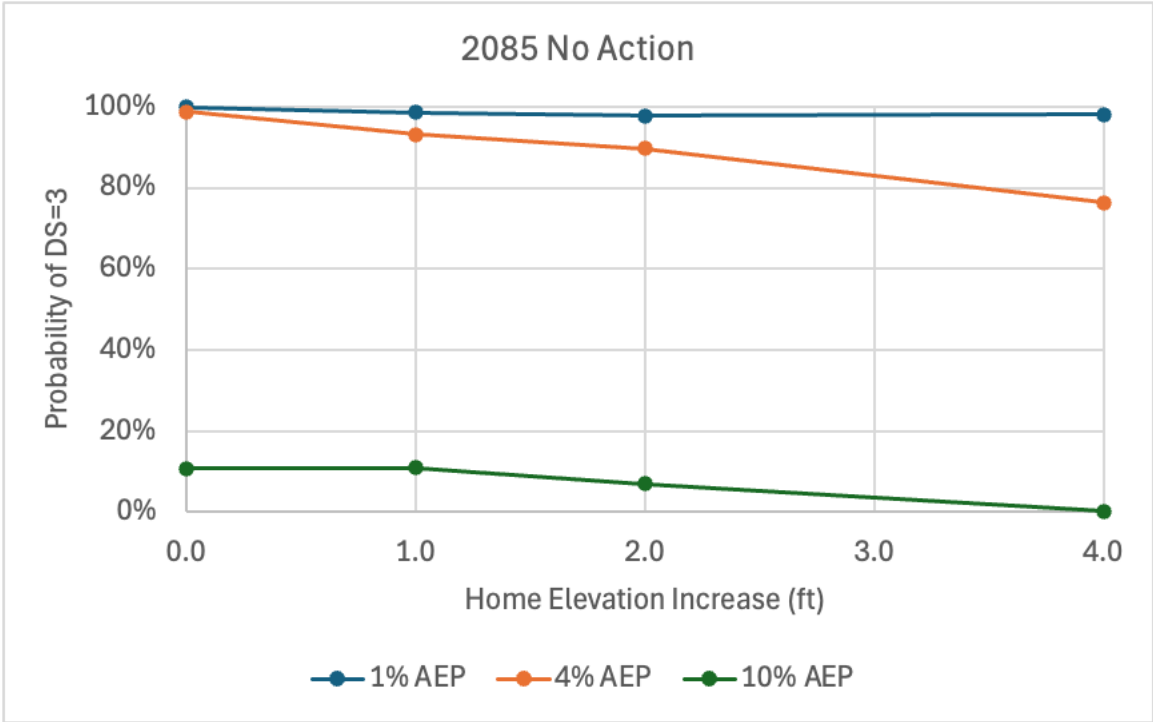
Conventionally Built Homes: Assessing Damage

Flood Damage	
Affected	• Any waterline in the crawl space or an unfinished basement when essential living space or mechanical components are not damaged or submerged. • Damage to a porch, carport, garage, and/or an outbuilding, etc.
Minor	• Waterline at 1 to 3 inches in an essential living space. • When waterline exceeds 3 inches but is below 18 inches, damage may be major or minor depending on the following factors: duration of the flood; contaminates in the water; if waterline reached outlets; and number of essential living spaces flooded. • Any waterline in a finished basement.
Major	• Waterline above 18 inches or the electrical outlets in an essential living space. • Waterline on the first floor (regardless of depth) of a residence when basement is completely full. • When waterline exceeds 3 inches but is below 18 inches, damage may be major or minor depending on the following factors: Duration of the flood; contaminates in the water; if waterline reached outlets; and number of essential living spaces flooded.
Destroyed	• Waterline at the roofline or higher, or complete failure of two or more major structural components (e.g., collapse of basement walls, foundation, walls, or roof).

Results/Findings

Results/Findings: Elevate Homes - P(f)





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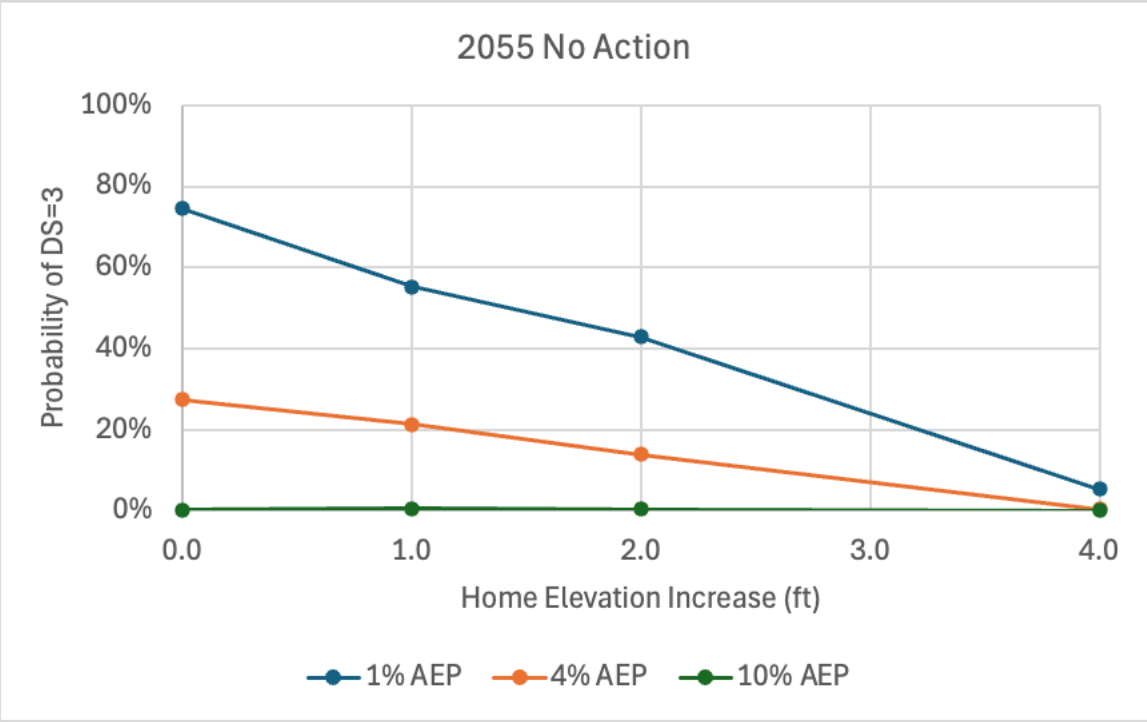

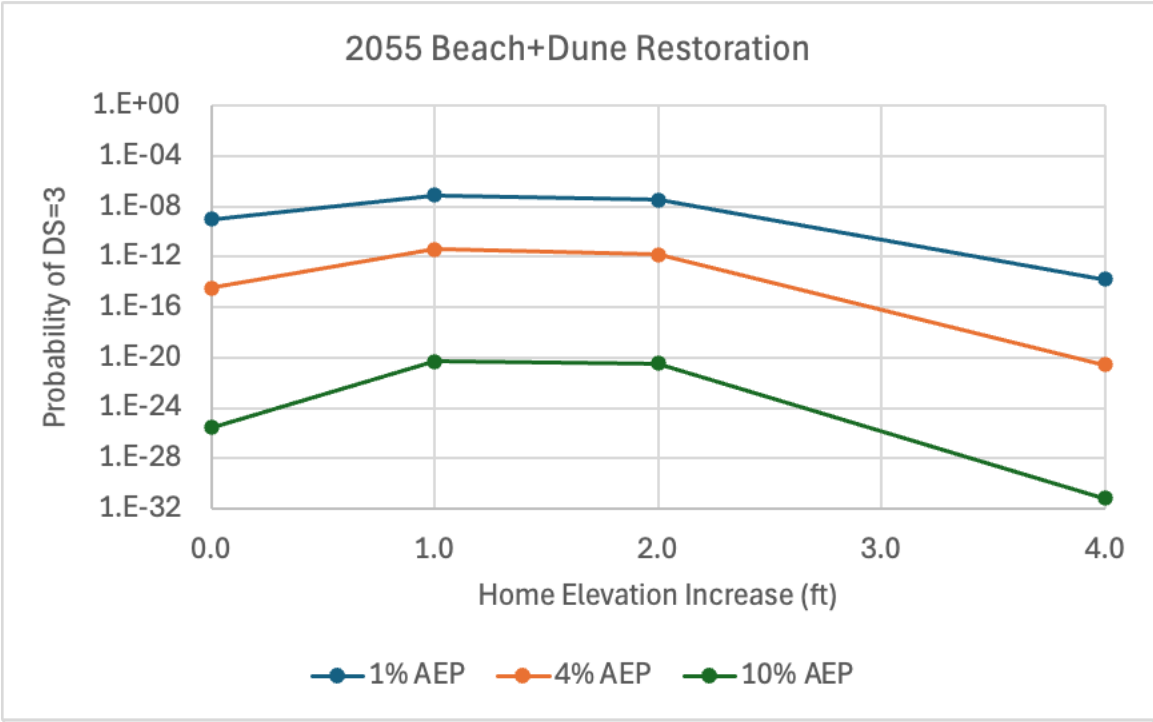

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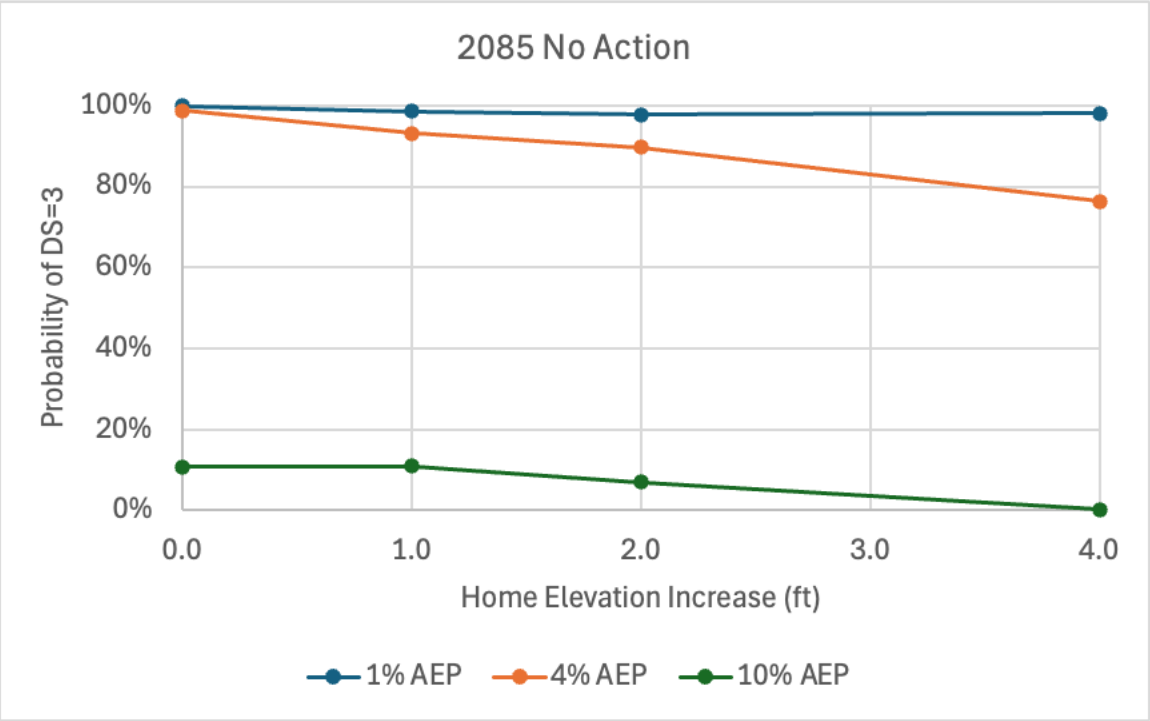
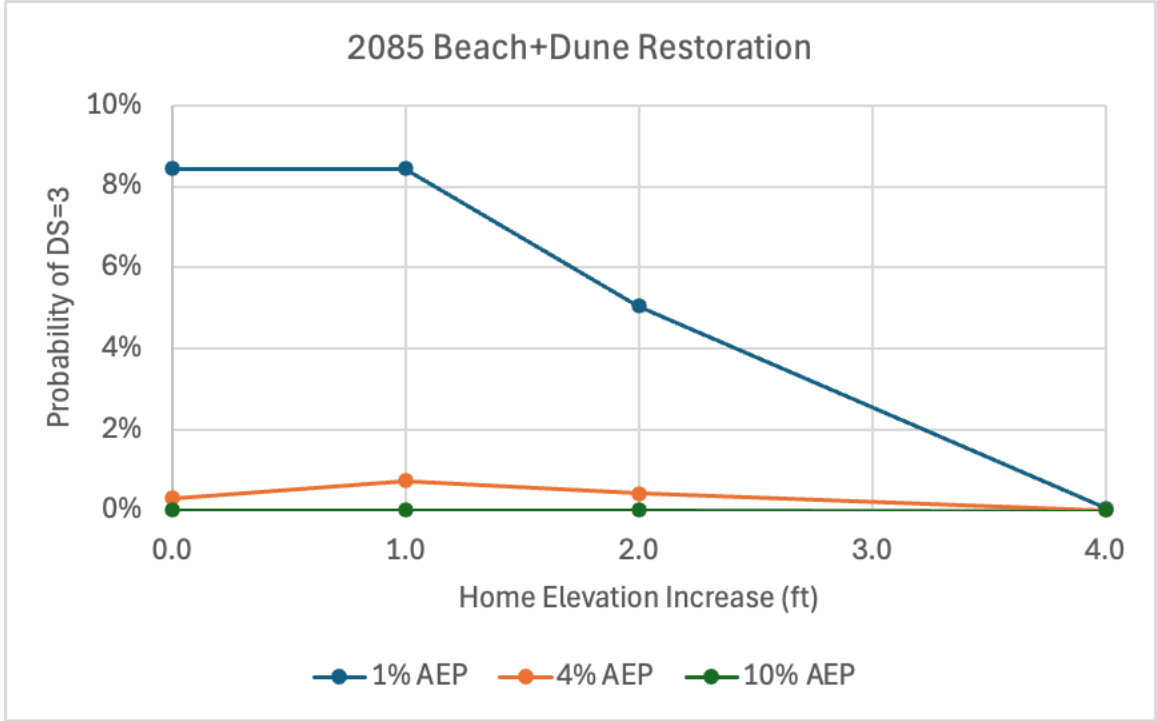
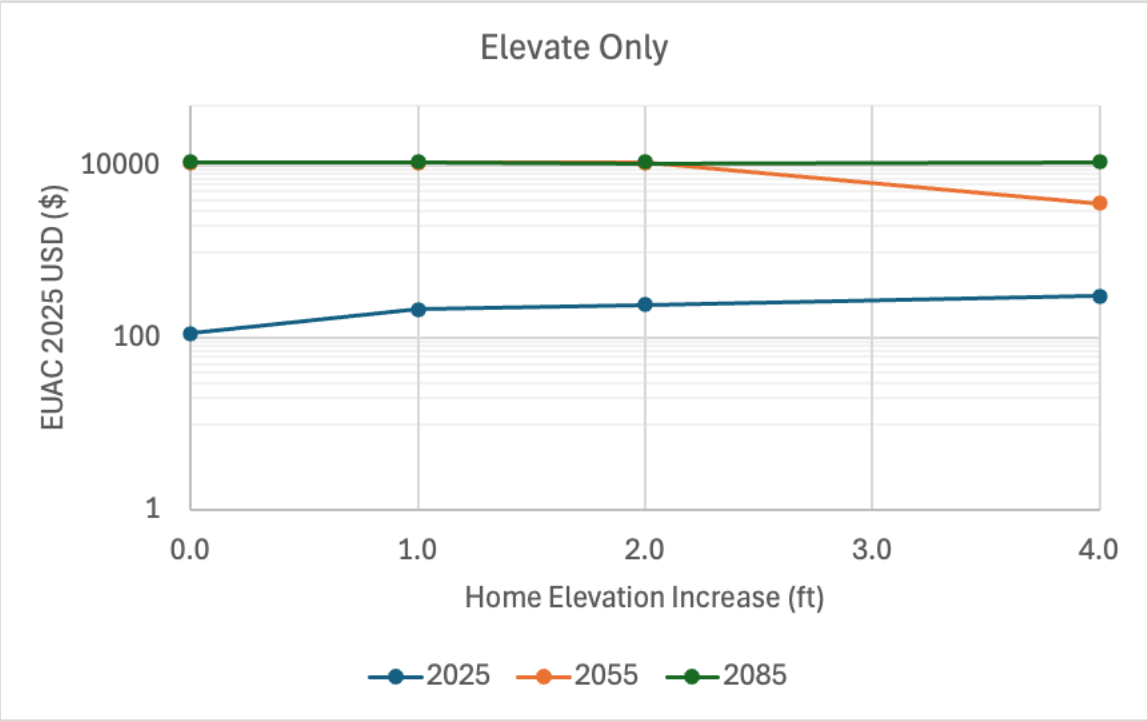
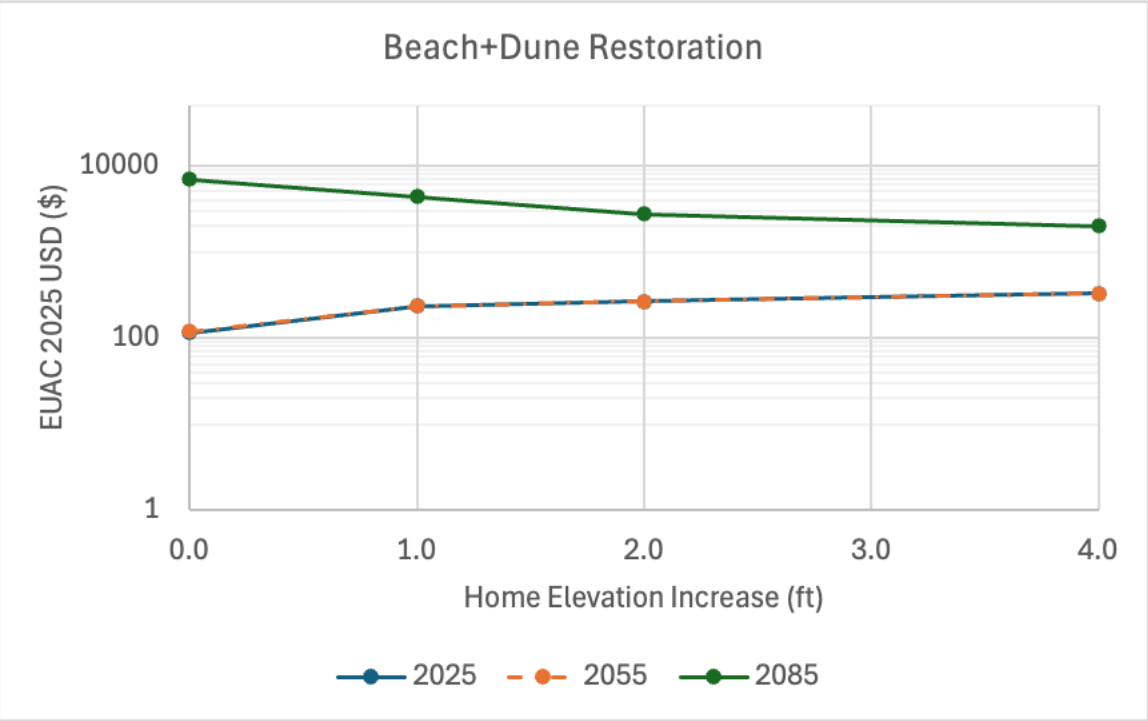




Results/Findings: Elevate Homes - $



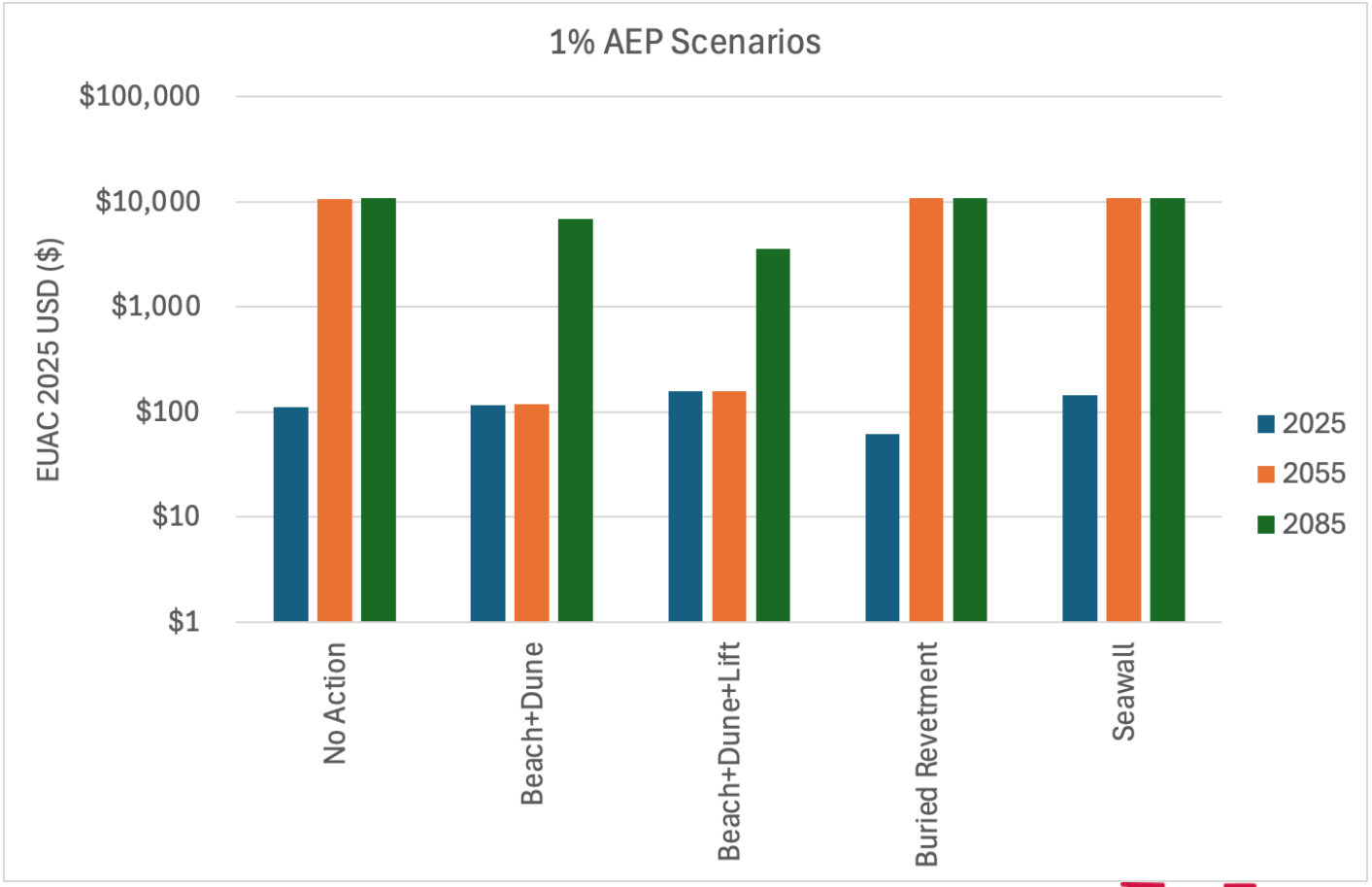


Results/Findings: Adaptation Costs

$$EUAC\ First\ Cost = P(i)\frac{(1+i)^N}{(1+i)^N - 1}$$

- P: cost of adaptation
- i: avg CPI (3.7%)
- N: time (30 yrs, 60 yrs)

Total EUAC = First Cost + Damage ($) x Scenario Probability



Results/Findings: EUAC Ratios

1% AEP		2055 Conditions
		do nothing
2025 Conditions	do nothing	95.7
	beach+dune	92.5
	beach+dune+lift	68.4
	buried revetment	173.9
	seawall	73.8

1% AEP / Raised +4 ft		2055 Conditions				
		do nothing	beach+dune	beach+dune+lift	buried revetment	seawall
2025 Conditions	do nothing	11.8	1.1	1.2	11.1	36.2
	beach+dune	11.1	1.0	1.1	10.4	33.9
	beach+dune+lift	9.8	0.9	1.0	9.2	30.1
	buried revetment	13.3	1.2	1.4	12.4	40.6
	seawall	10.2	0.9	1.0	9.5	31.1

Next Steps

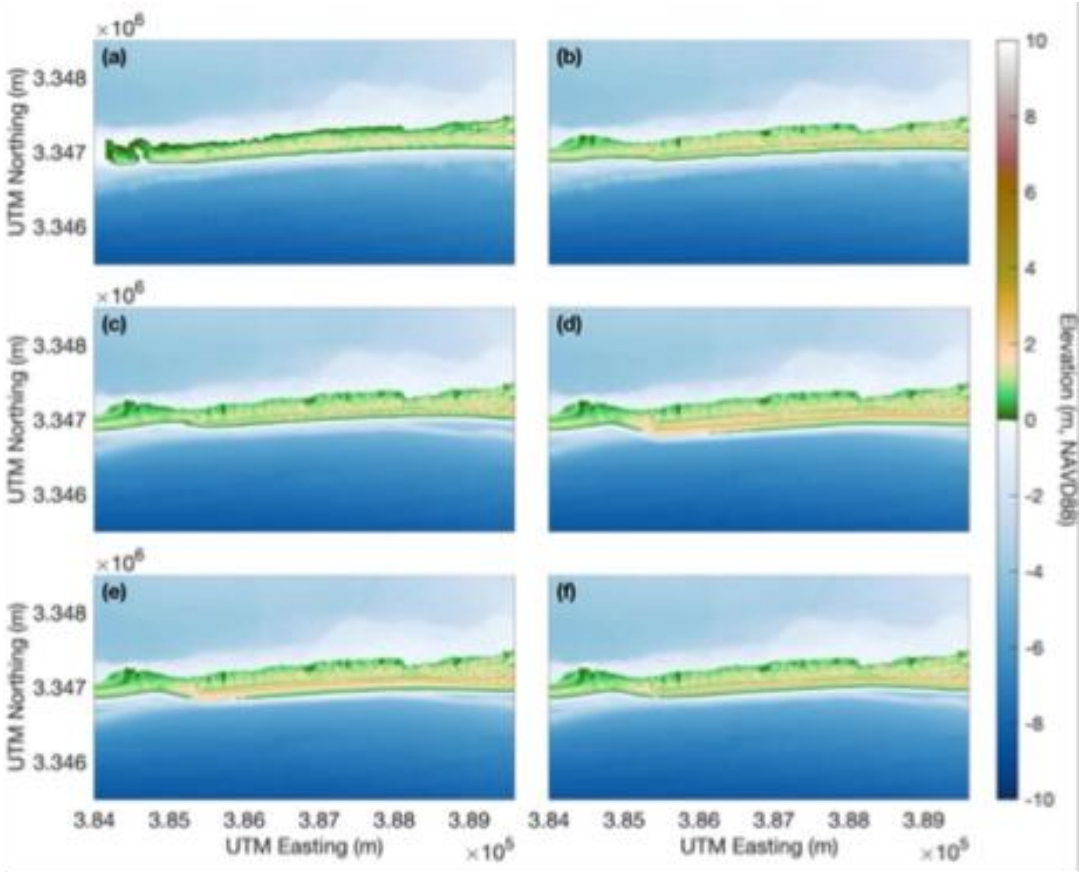
Next Steps

1. Complete residential building vulnerability assessment
2. Reassess residential building vulnerability with resilient adaptations (in 2D)
3. Perform economic analysis
4. Finalize adaptation pathways for risk, vulnerability, cost

https://www.expedia.com/Dauphin-Island.dx182896

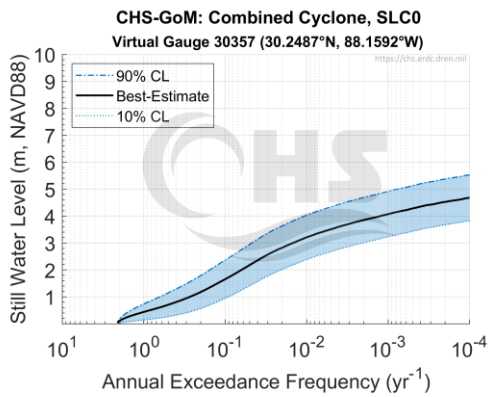
Sneak Peek – 2D Modeling

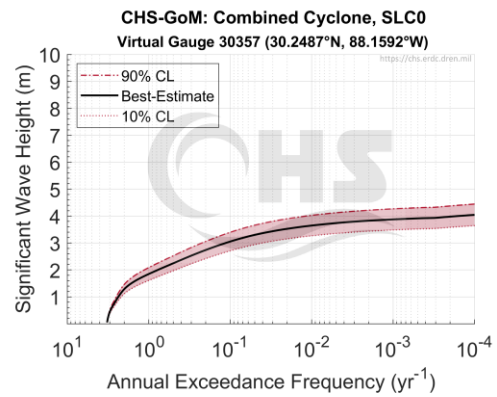
1. **2D XBeach Simulations**
   - Resilient Adaptations
   - AEP and SLR
2. Existing + Future AEP Conditions
   - Baseline and Future
3. Preliminary Assessments

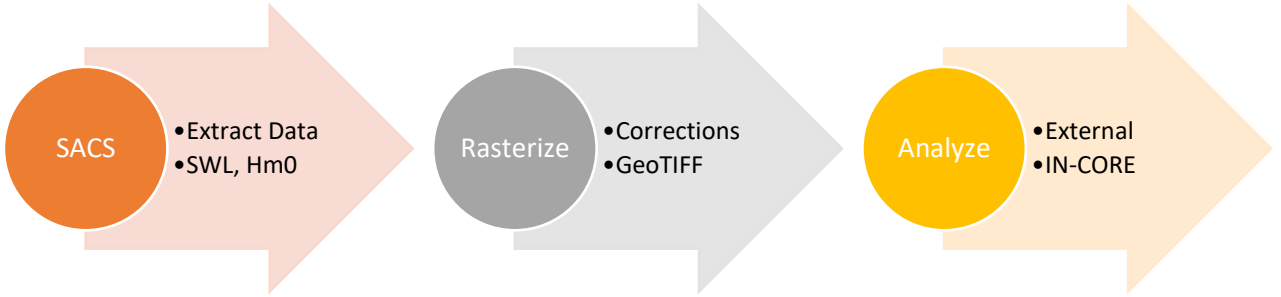


Sneak Peek – 2D Modeling

1. 2D XBeach Simulations
   - Resilient Adaptations
   - AEP and SLR
2. **Existing + Future AEP Conditions**
   - 0.2% AEP / SLR1 / SLR2
3. Preliminary Assessments







Sneak Peek – 2D Modeling

1,910 buildings of archetype 1, 2, 20

3. Preliminary Assessments

Sneak Peek – 2D Modeling

1% AEP

$25M

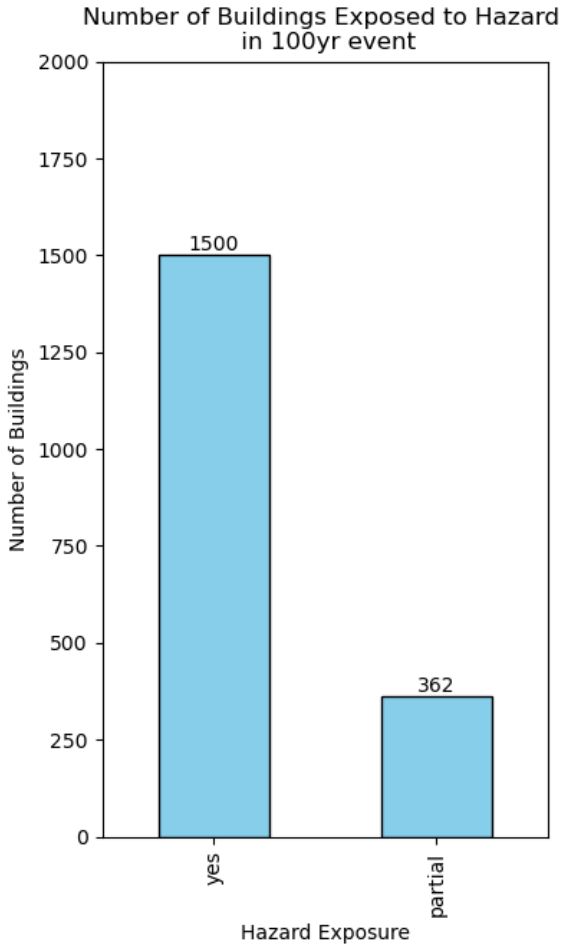
+0.83 m SLR

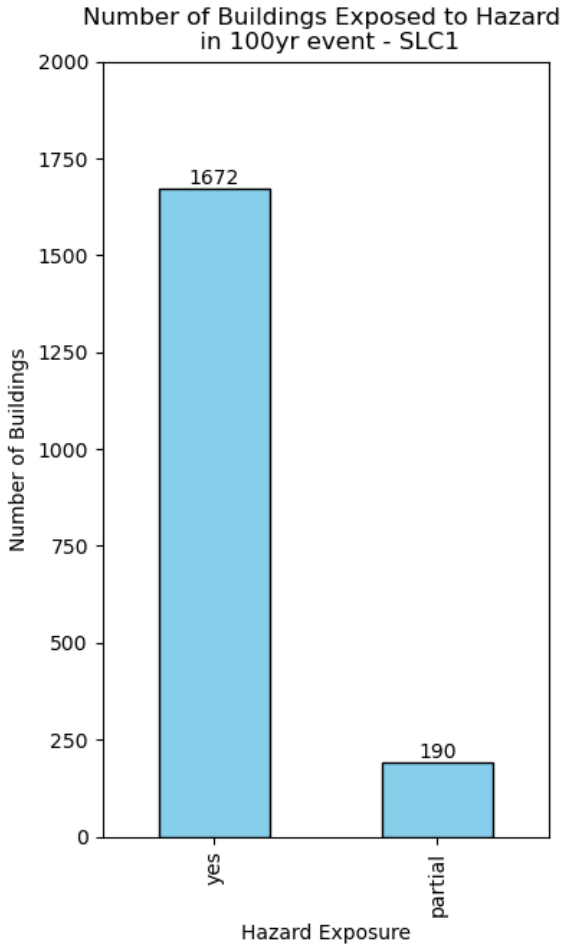
$132M

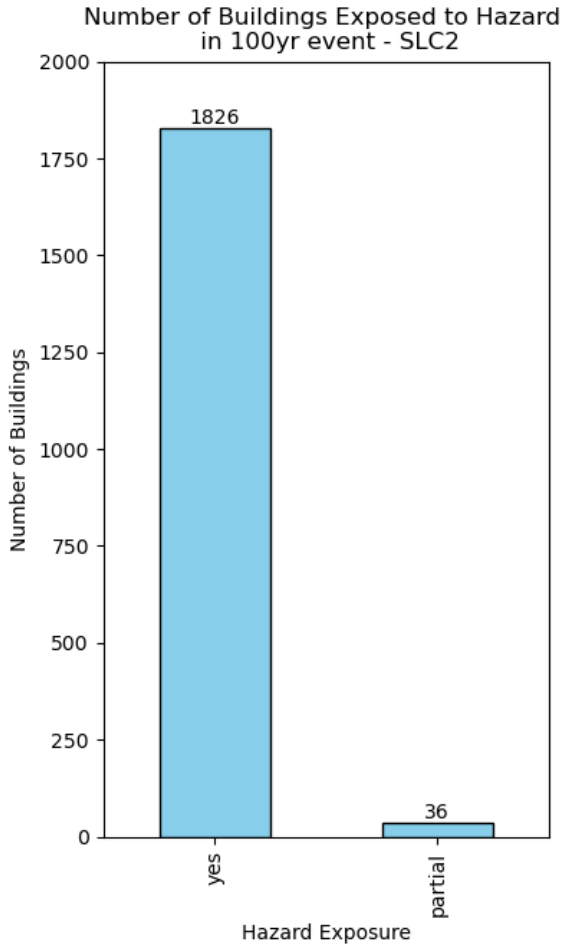
+2.24 m SLR

$282M

Sneak Peek – 2D Modeling







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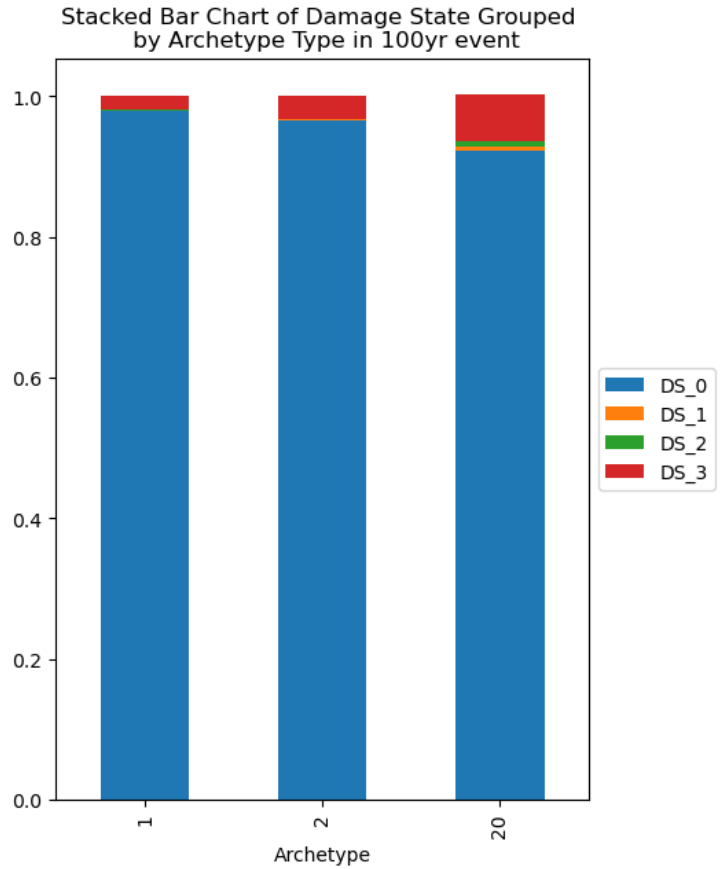

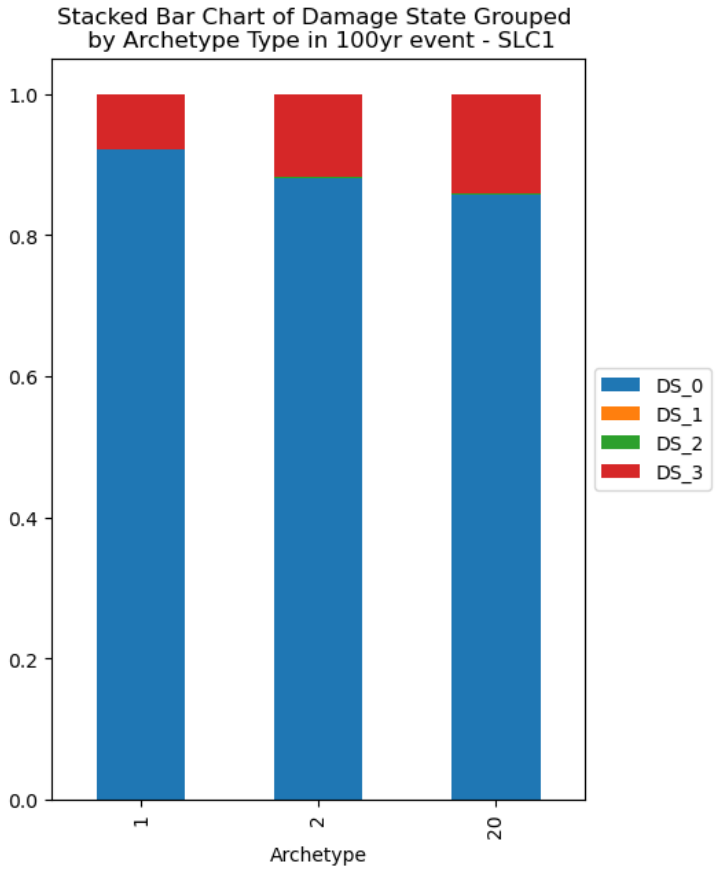

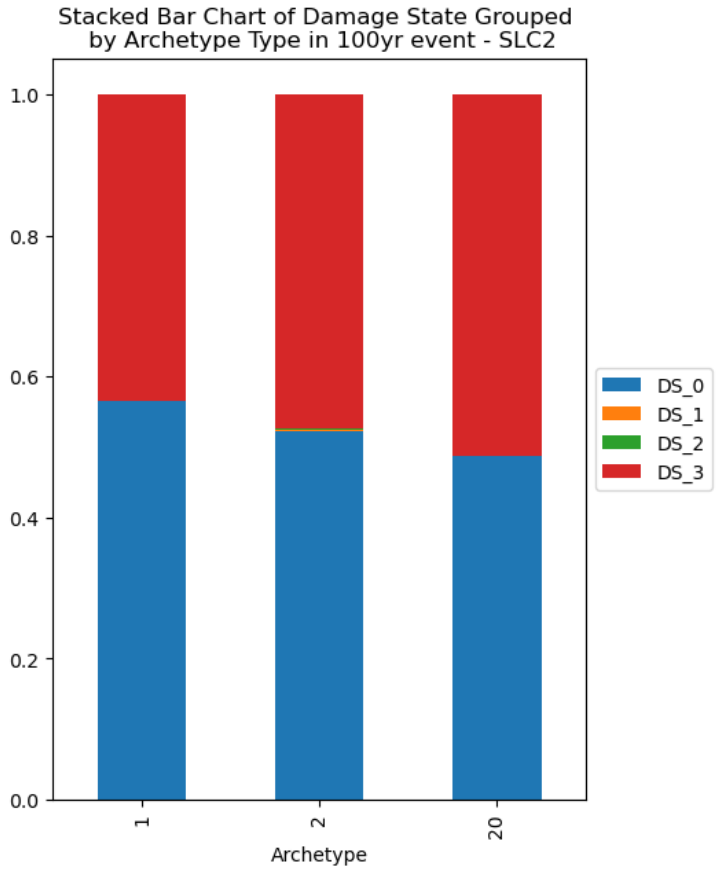

Please contact me if you are interested in our work or would like to be contacted with updates.

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