

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

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The logo for Goodwyn Mills Cawood (GMC) consists of the letters 'G', 'M', and 'C' in a bold, orange, sans-serif font. The 'G' and 'C' are larger and more prominent than the 'M'.

Goodwyn Mills Cawood

The logo for the University of South Alabama (USA) features the letters 'USA' in a stylized, red, serif font. The 'U' and 'A' are larger and more prominent than the 'S'.

UNIVERSITY OF
SOUTH ALABAMA

The logo for Resilience features the word 'Resilience' in a bold, black, sans-serif font. Above the 'i' and 'e' are three stylized house icons in black, green, and yellow. A white speech bubble tail extends from the bottom left of the word.The logo for the US Coastal Research Program (USCRP) features a circular emblem with a green and yellow gradient. Below the emblem, the text 'USCRP' is written in a bold, black, sans-serif font, with 'US COASTAL RESEARCH PROGRAM' in a smaller font below it.

asbpa

American Shore & Beach Preservation Association

Advocating for healthy coastlines.

Established 1926

100th Anniversary
Centennial Celebration

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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](https://www.asbpa.org)!

**Scan to Vote at
[ASBPA.org](https://www.asbpa.org)**

Presentation Outline

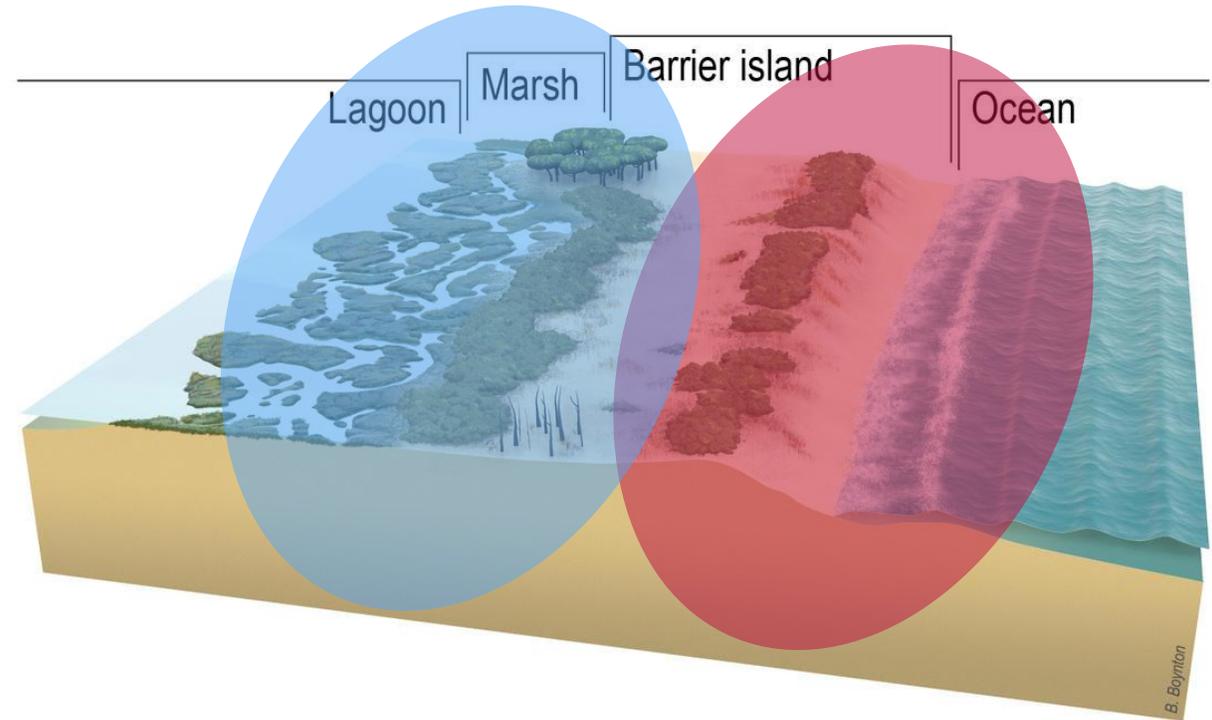
- Overview
- Approach
- Methods
- Results
- Next Steps

Overview

Overarching Goal

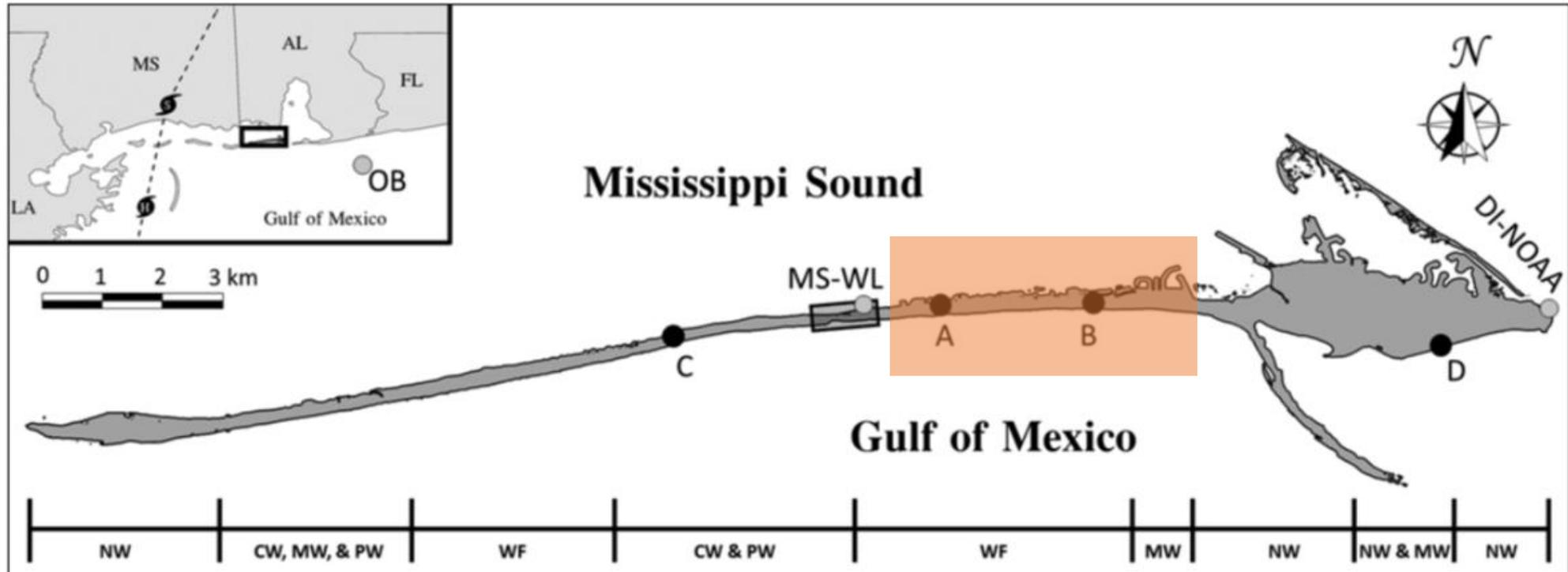
Flood Risk Management (FRM)

- 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



Mississippi Sound

Gulf of Mexico

Mobile Bay



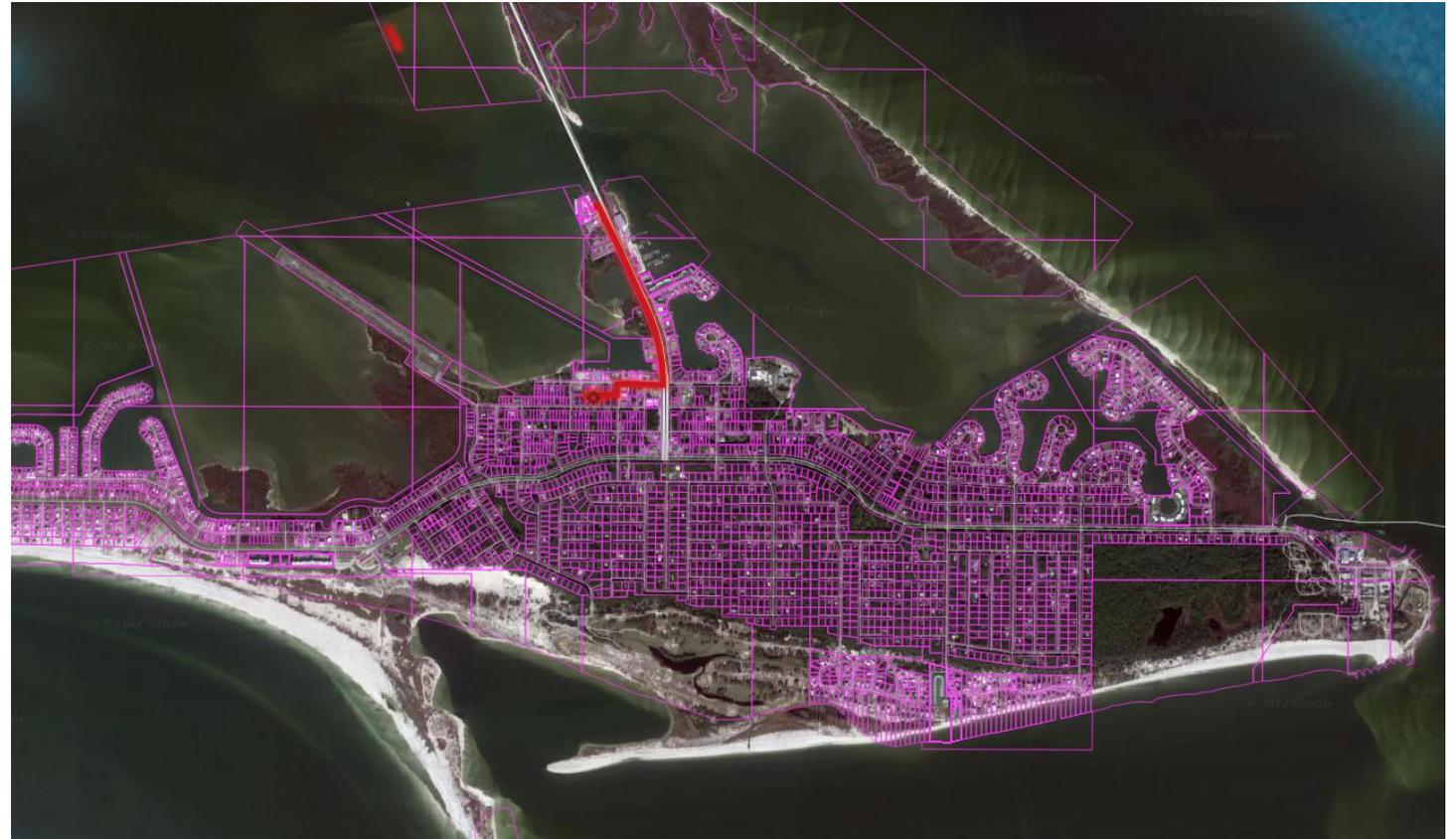
Dauphin Island, Alabama

Mississippi Sound

Gulf of Mexico

Dauphin Island, Alabama

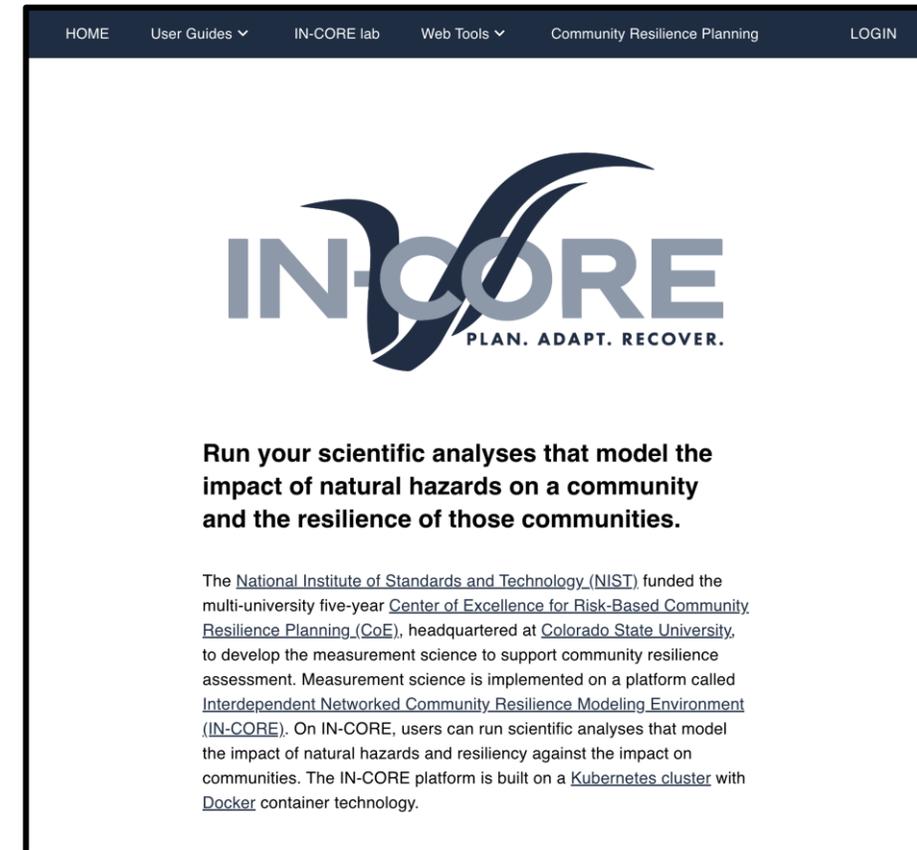
- Parcel Data
- Building Footprints
- Transportation
- Power
- Water
- Sewer
- Critical Facilities



Approach

Approach

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



HOME User Guides IN-CORE lab Web Tools Community Resilience Planning LOGIN

IN-CORE

PLAN. ADAPT. RECOVER.

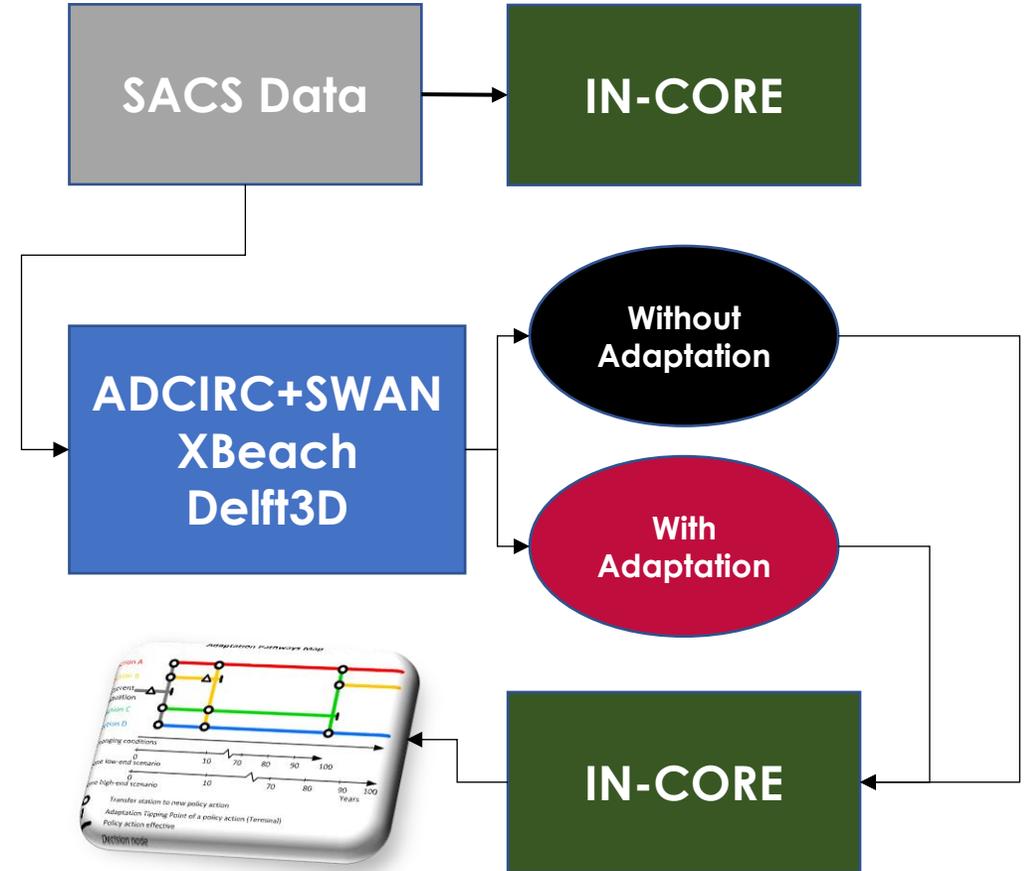
Run your scientific analyses that model the impact of natural hazards on a community and the resilience of those communities.

The [National Institute of Standards and Technology \(NIST\)](#) funded the multi-university five-year [Center of Excellence for Risk-Based Community Resilience Planning \(CoE\)](#), headquartered at [Colorado State University](#), to develop the measurement science to support community resilience assessment. Measurement science is implemented on a platform called [Interdependent Networked Community Resilience Modeling Environment \(IN-CORE\)](#). On IN-CORE, users can run scientific analyses that model the impact of natural hazards and resiliency against the impact on communities. The IN-CORE platform is built on a [Kubernetes cluster](#) with [Docker](#) container technology.

<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

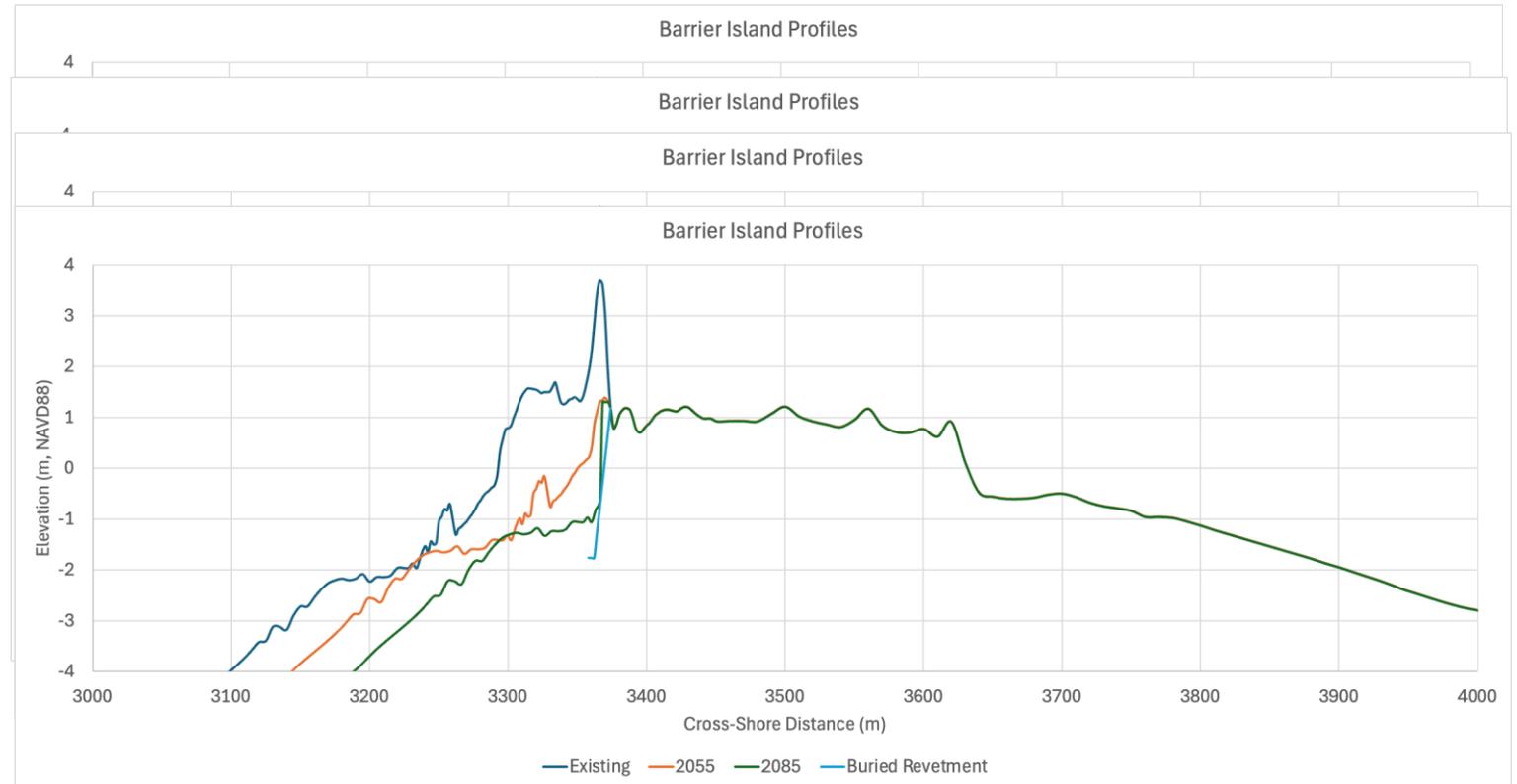
**IPCC AR6 SSP5-8.5 50th Percentile*

Adaptation Scenarios

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

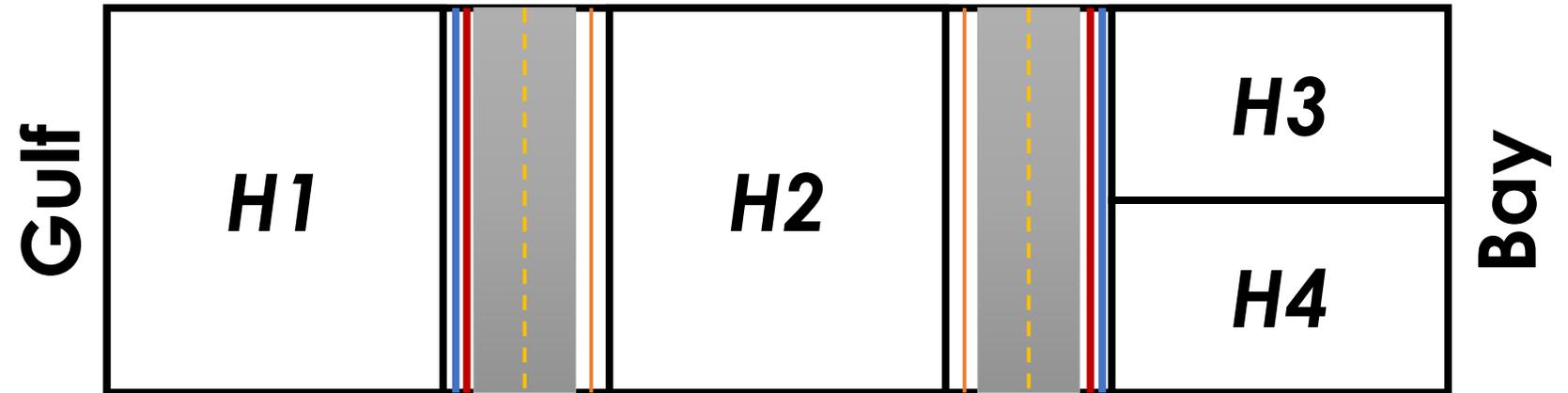
1D XBeach Modeling

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



Infrastructure Model

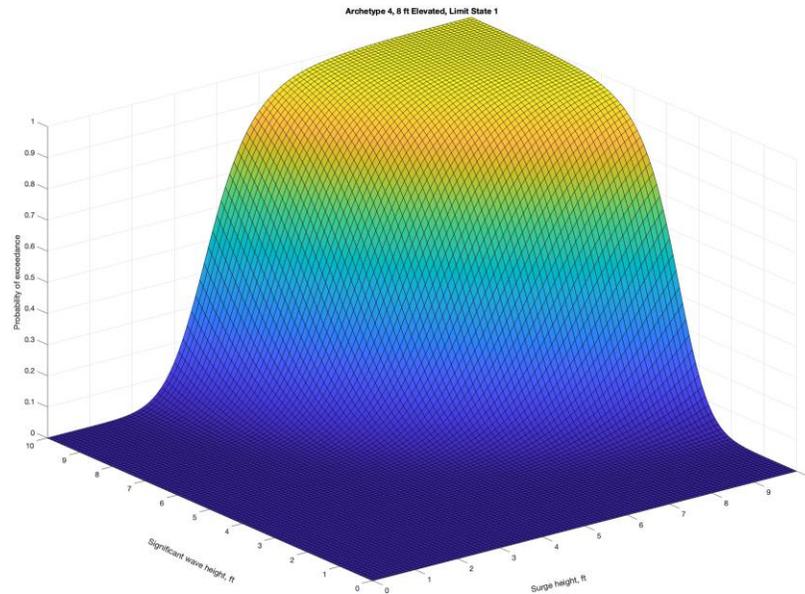
- Homes
- Roads
- Telecoms
- Water
- Sewer



Infrastructure Model

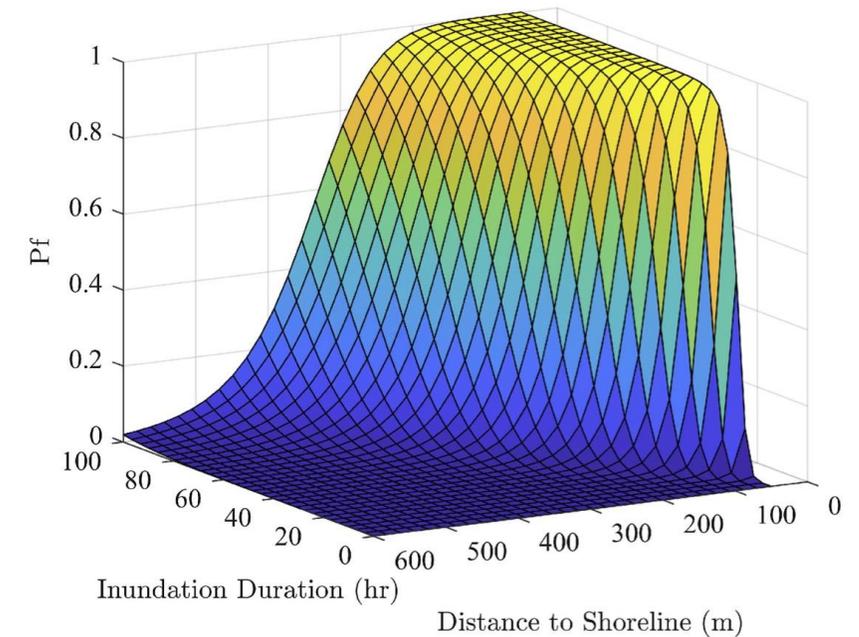
- Homes
- Roads
- Telecoms
- Water
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Elevated Structure Fragility



Do et al. (TBD)

Coastal Roadway Fragility



Darestani et al. (2021)

Infrastructure Model

Damage State Classification

DS=1 ←

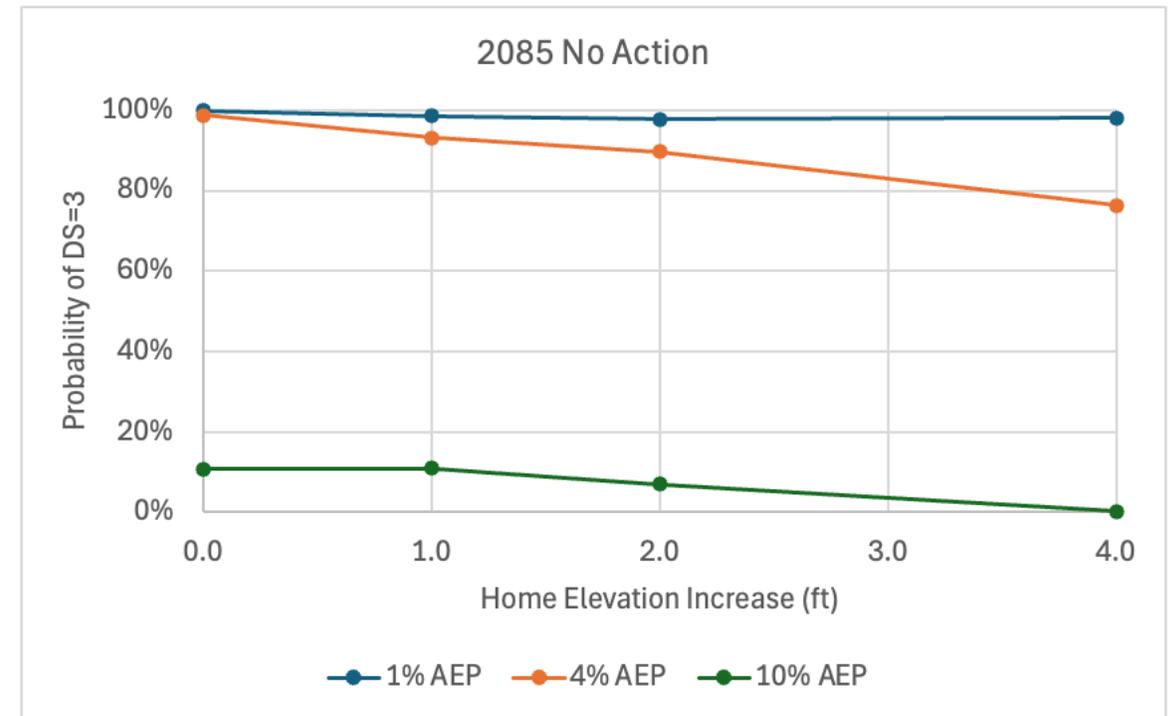
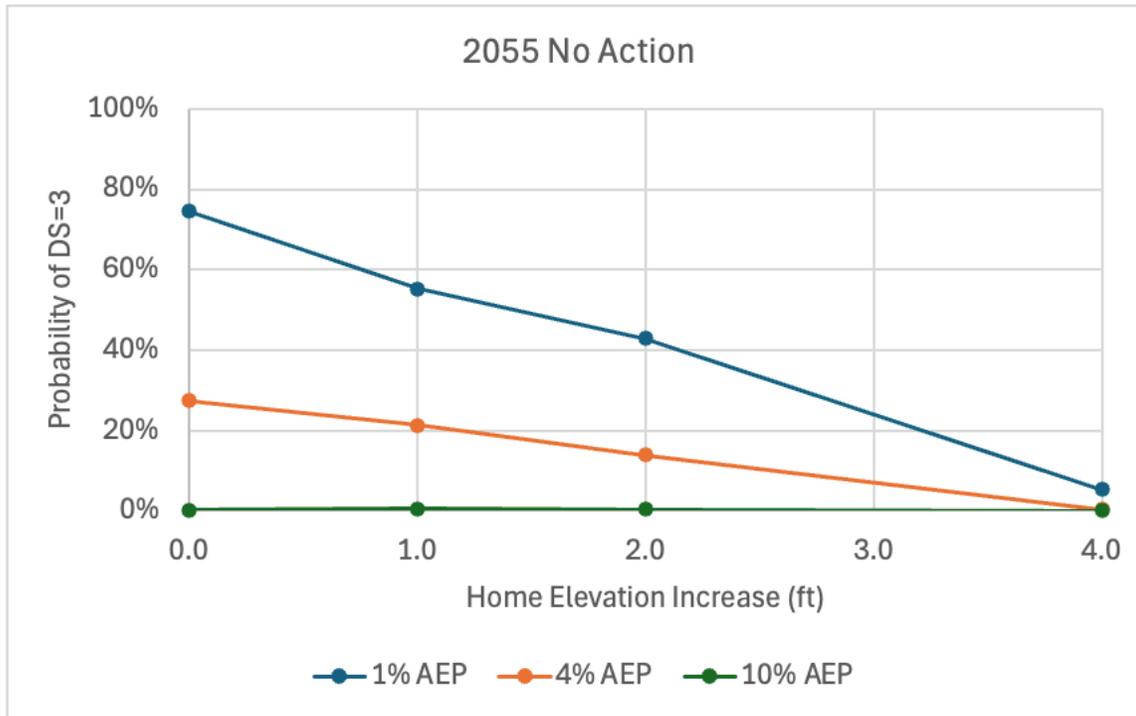
DS=2 ←

DS=3 ←

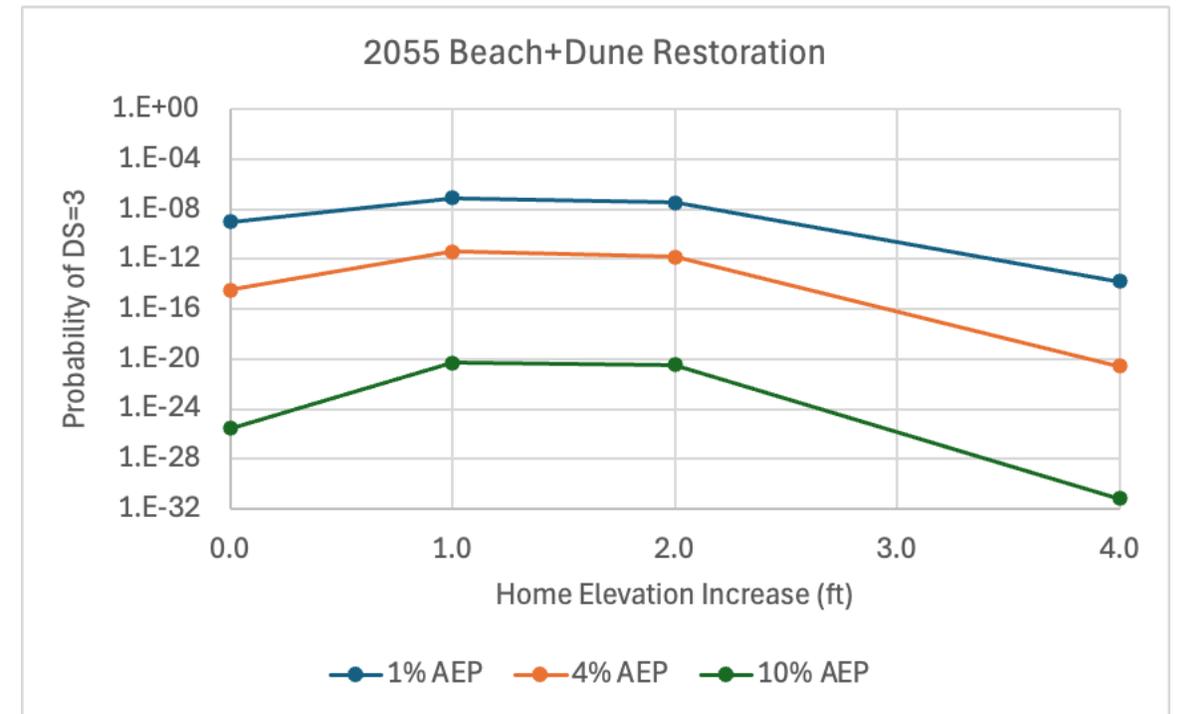
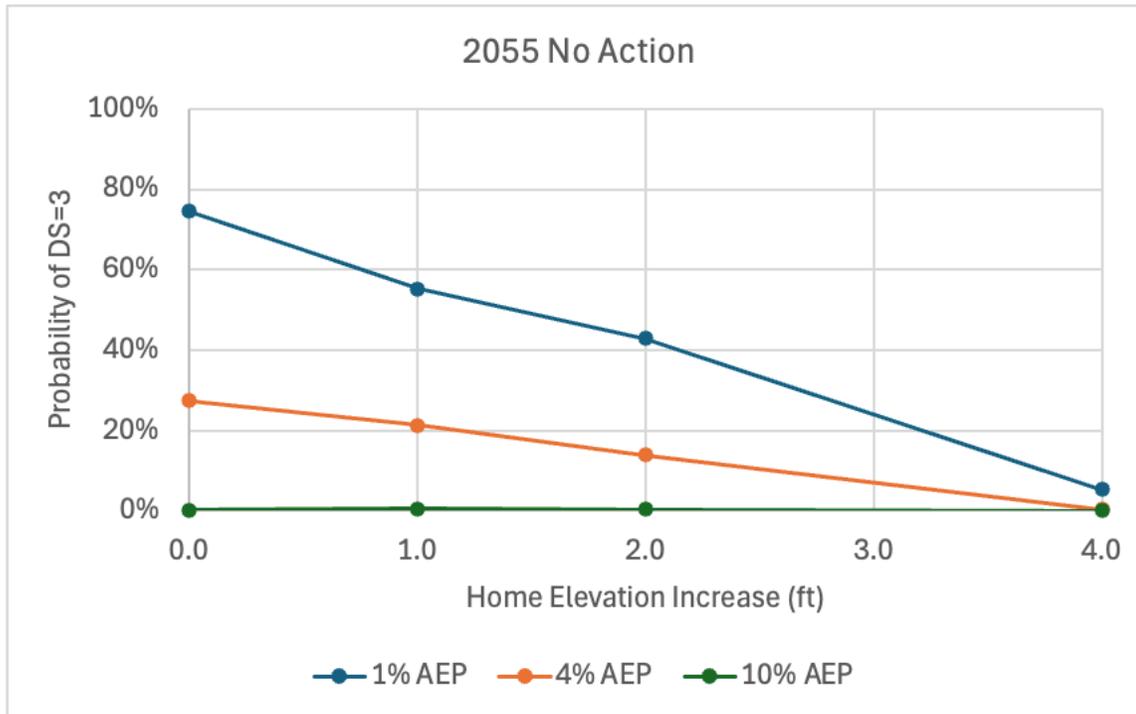
Flood Damage	
Affected	<ul style="list-style-type: none"> Any waterline in the crawl space or an unfinished basement when essential living space or mechanical components are not damaged or submerged. Damage to a porch, carport, garage, and/or an outbuilding, etc.
Minor	<ul style="list-style-type: none"> 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	<ul style="list-style-type: none"> 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	<ul style="list-style-type: none"> 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

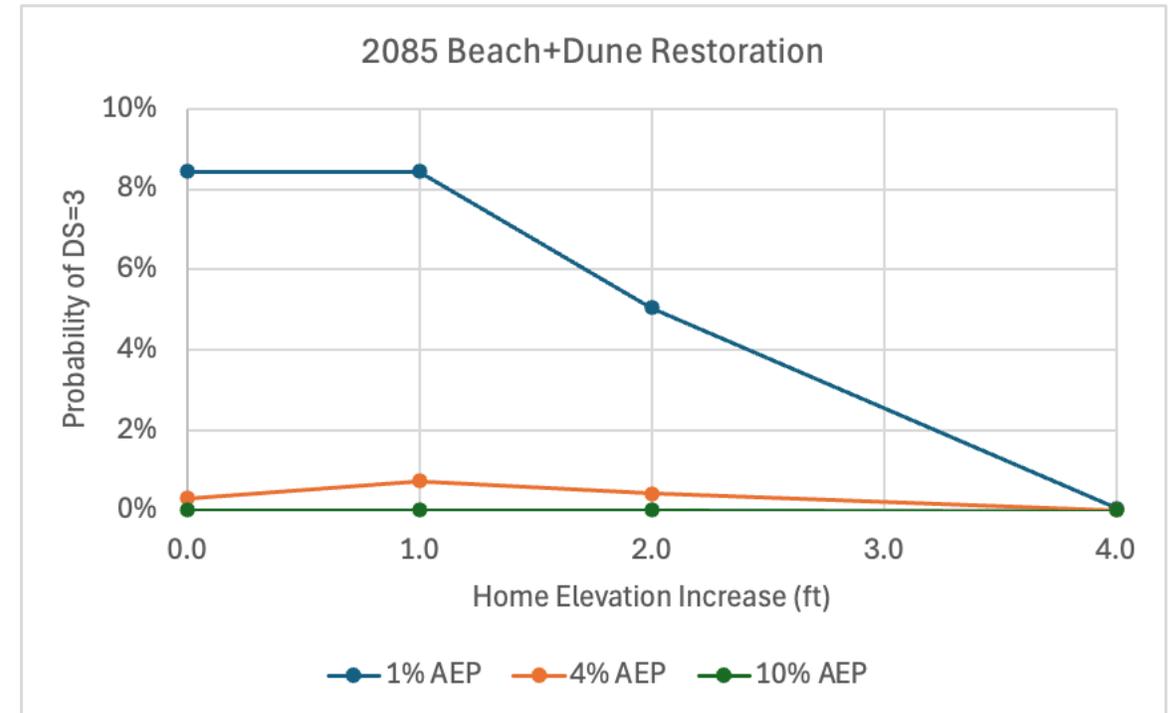
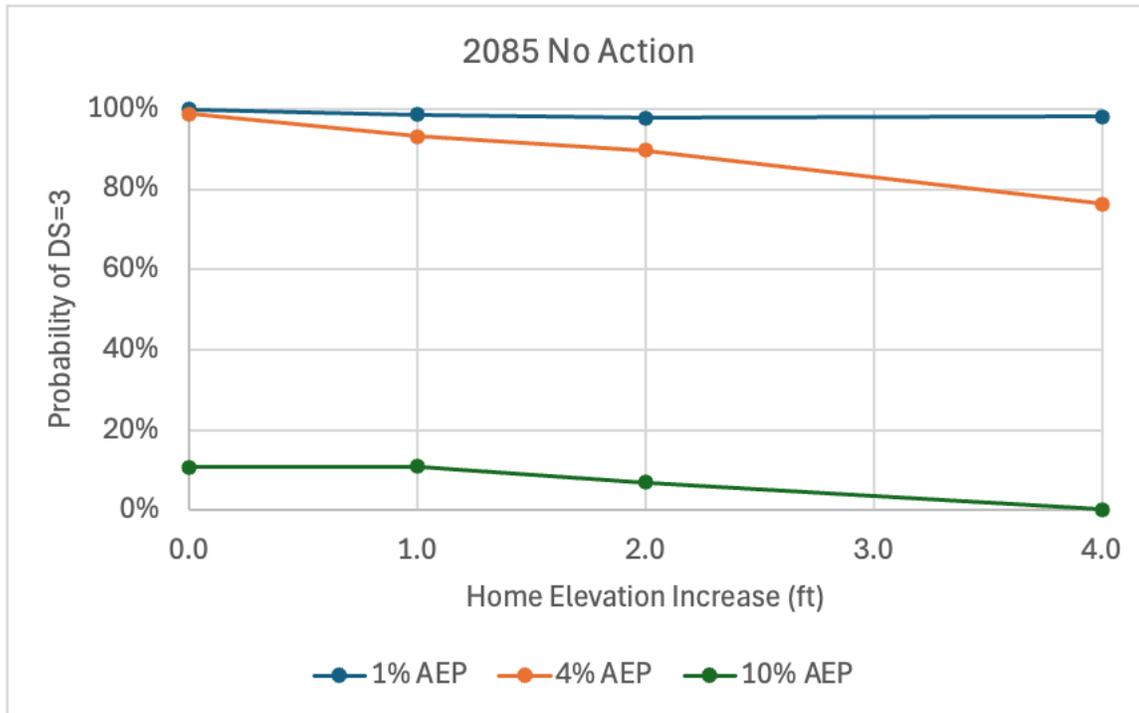
Results/Findings: Elevate Homes - P(f)



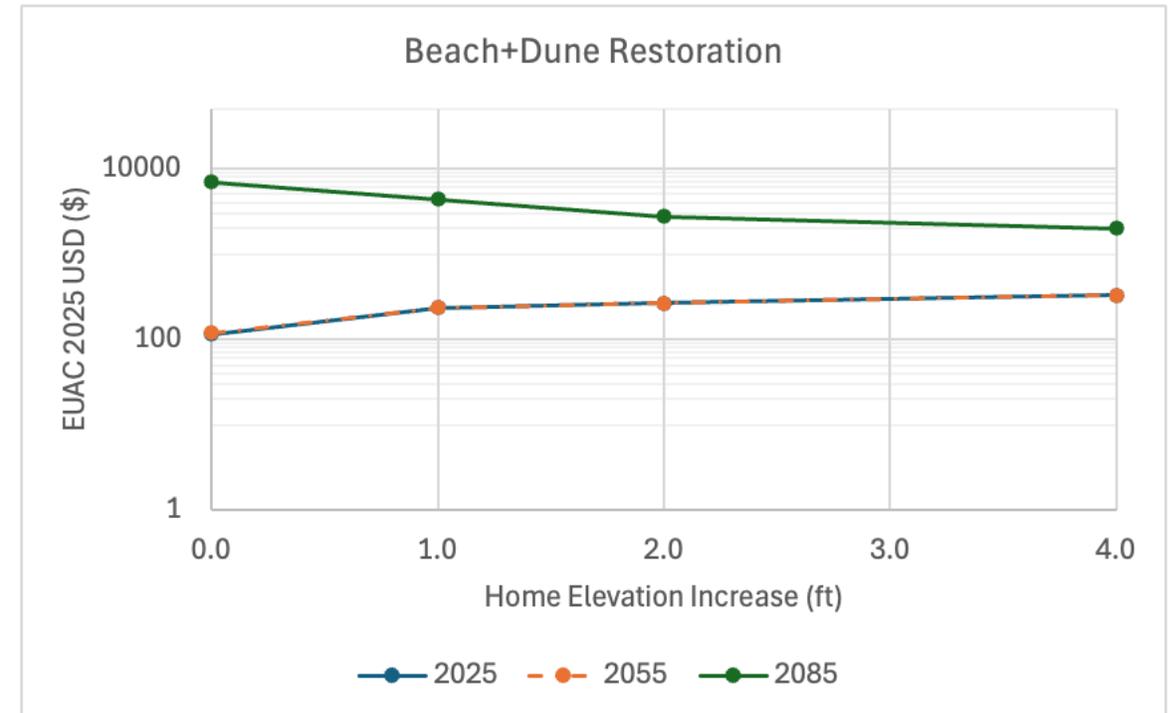
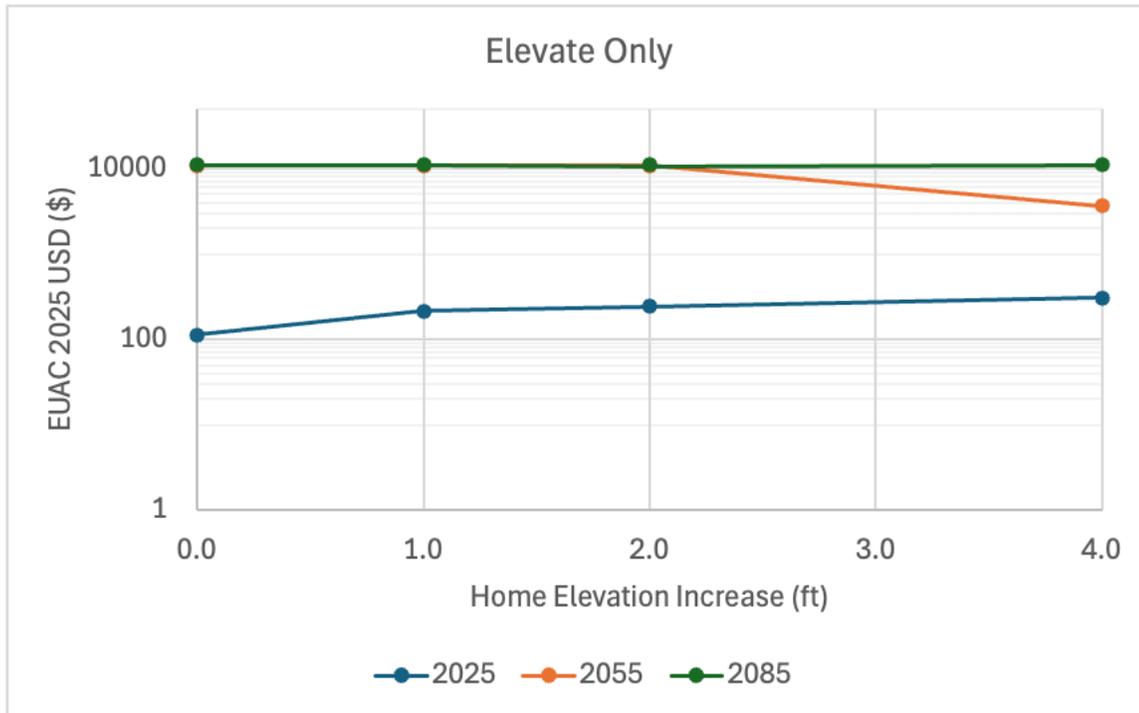
Results/Findings: Elevate Homes - P(f)



Results/Findings: Elevate Homes - P(f)



Results/Findings: Elevate Homes - \$

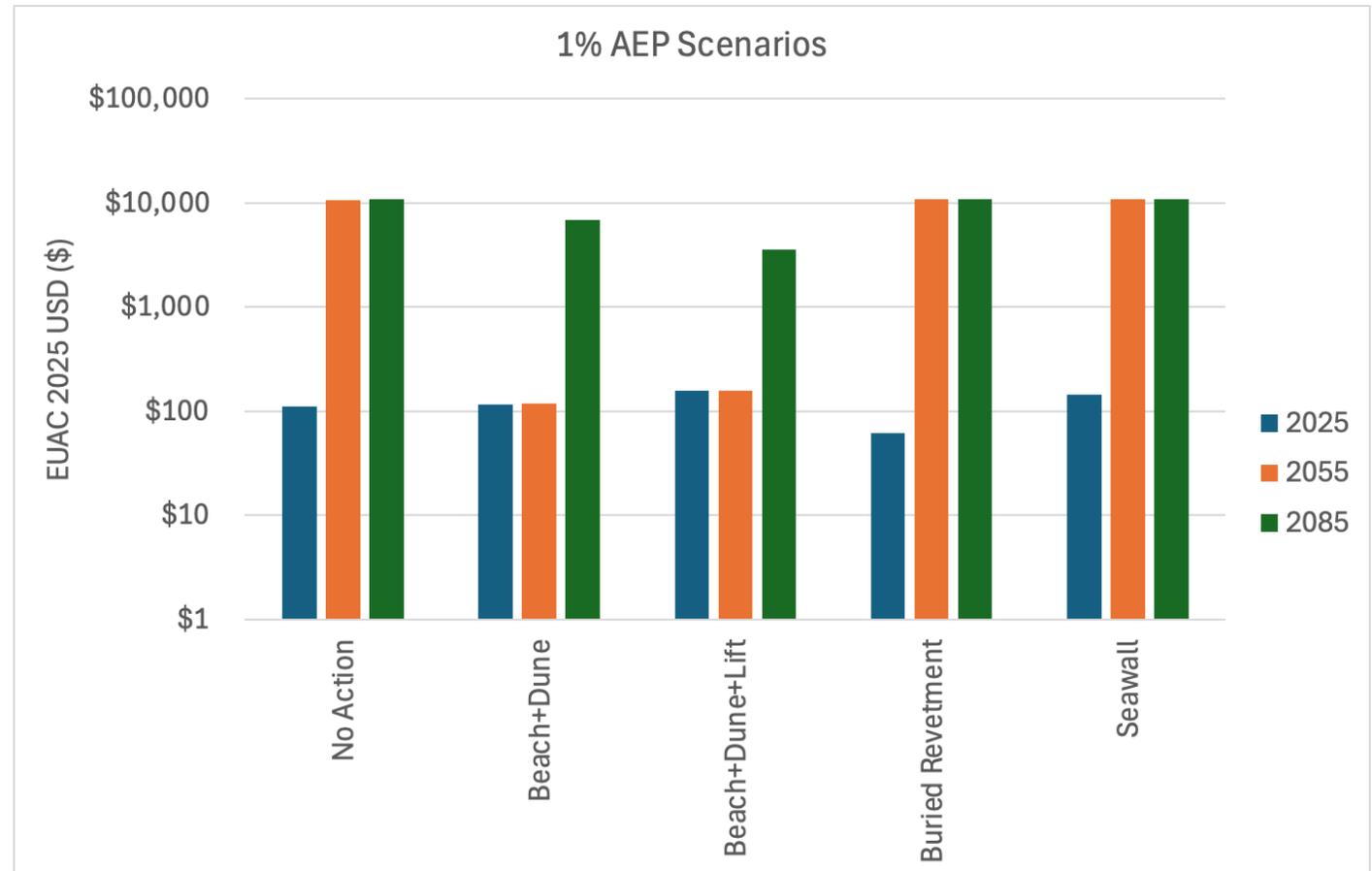


Results/Findings: Adaptation Costs

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

- 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

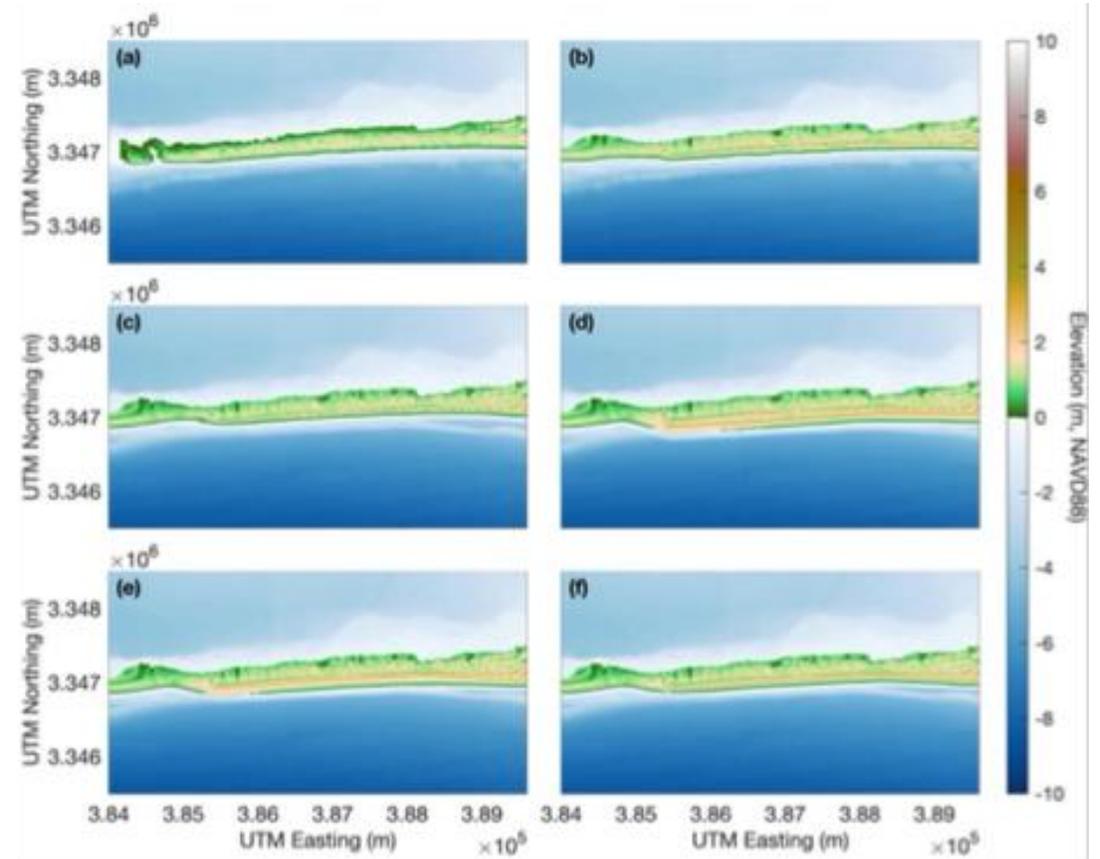
1. 2D XBeach Simulations

- Resilient Adaptations
- AEP and SLR

2. Existing + Future AEP Conditions

- Baseline and Future

3. Preliminary Assessments



Sneak Peek – 2D Modeling

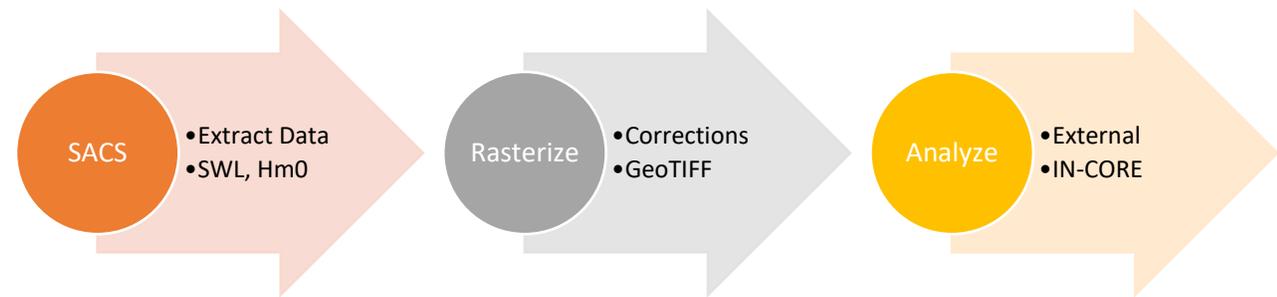
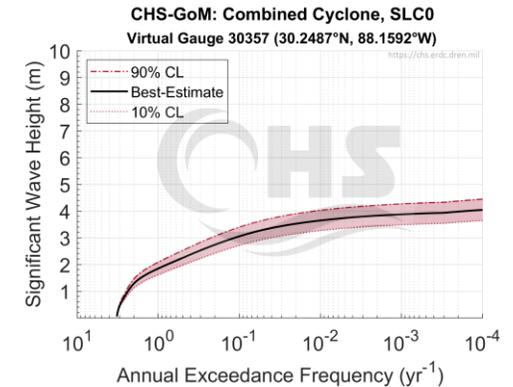
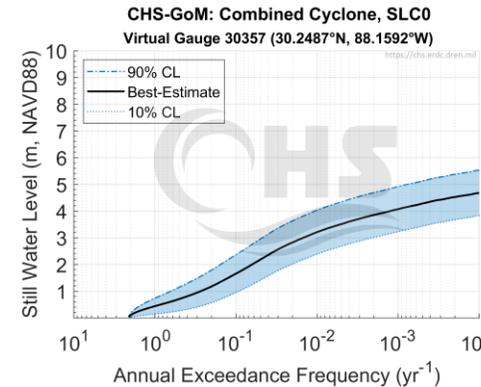
1. 2D XBeach Simulations

- Resilient Adaptations
- AEP and SLR

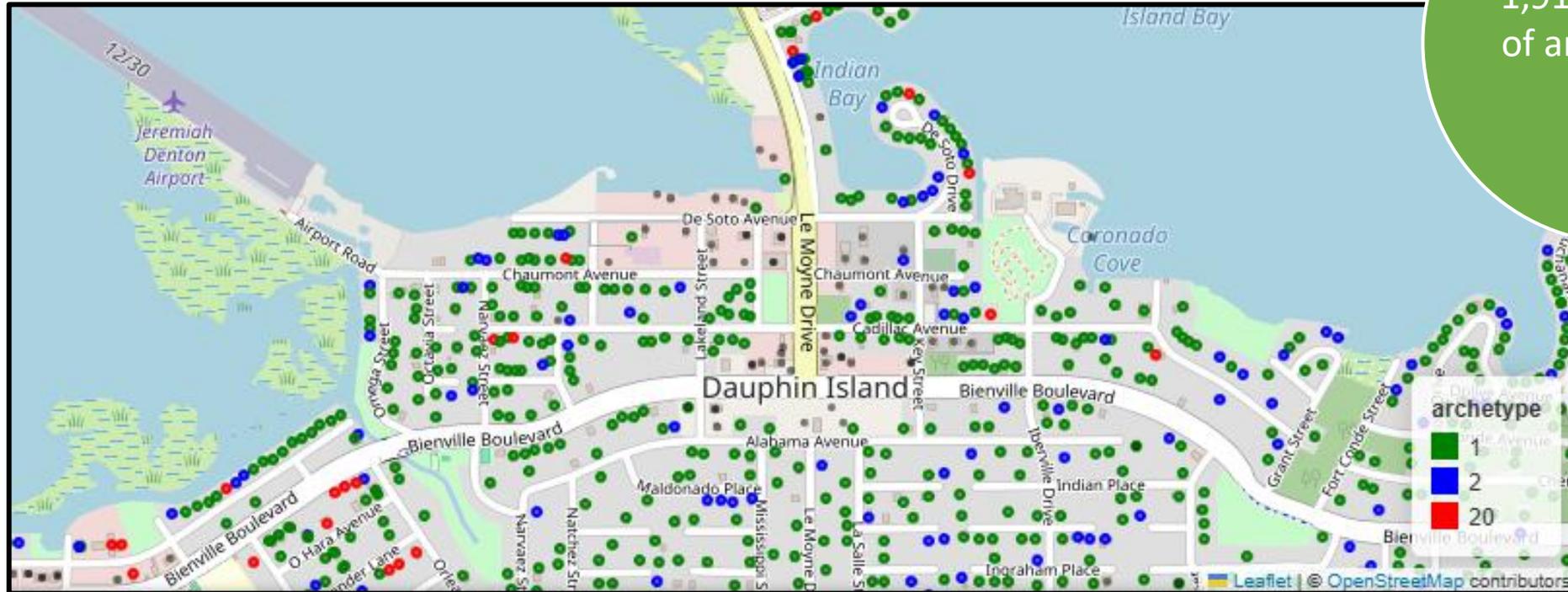
2. Existing + Future AEP Conditions

- 0.2% AEP / SLR1 / SLR2

3. Preliminary Assessments



Sneak Peek – 2D Modeling



3. Preliminary Assessments

Sneak Peek – 2D Modeling



1% AEP

\$25M

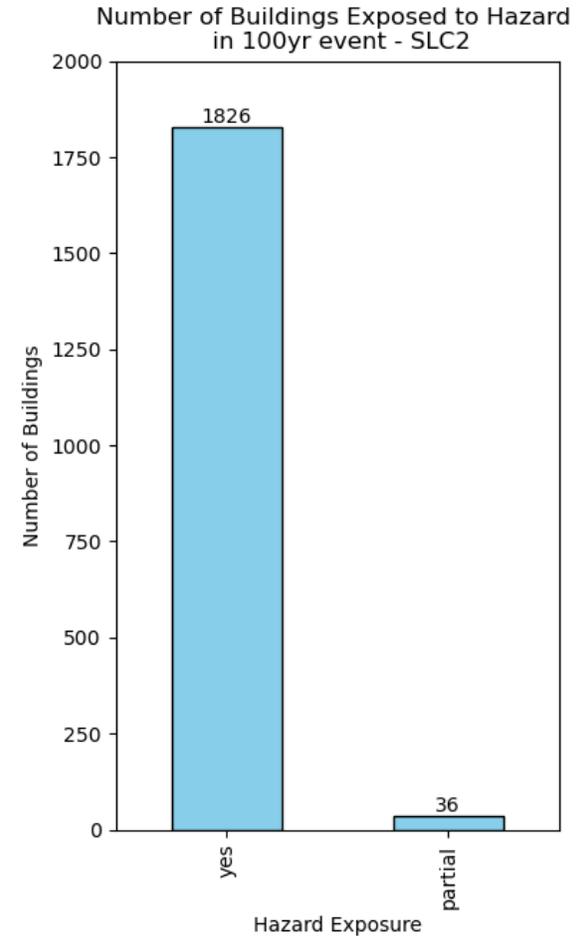
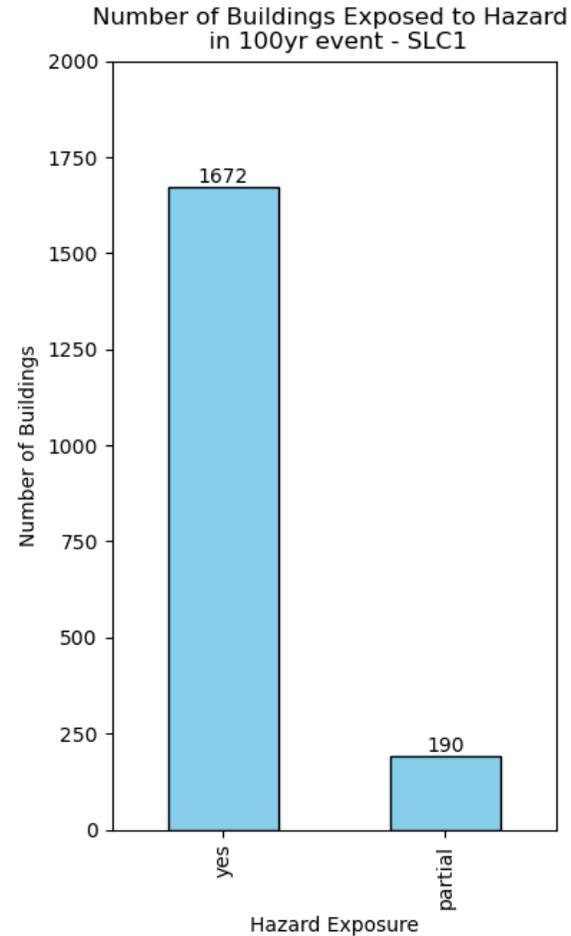
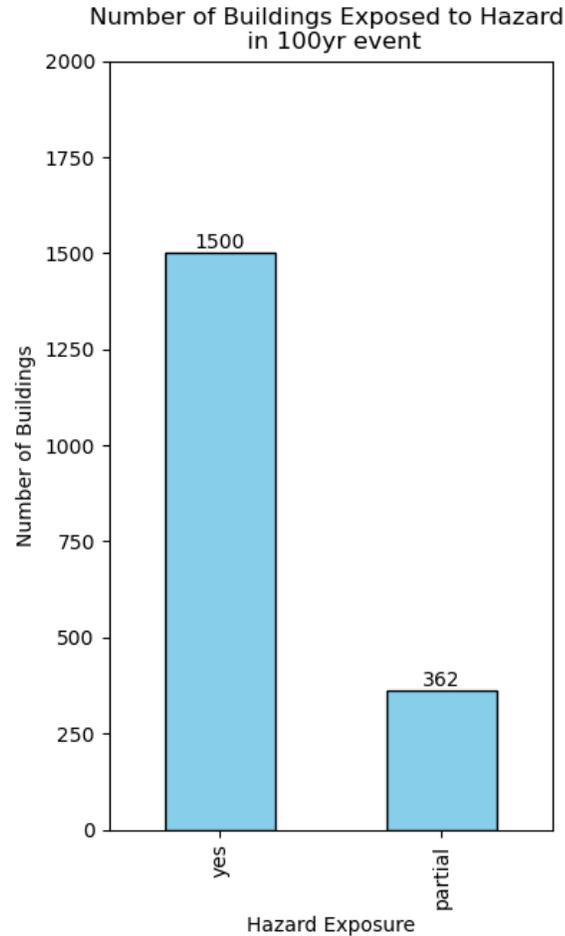
+0.83 m SLR

\$132M

+2.24 m SLR

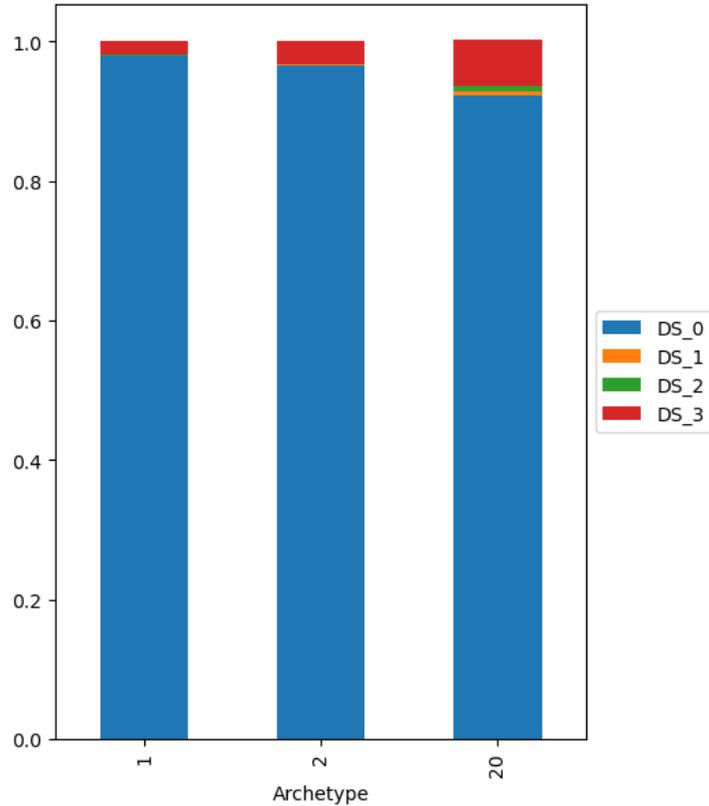
\$282M

Sneak Peek – 2D Modeling

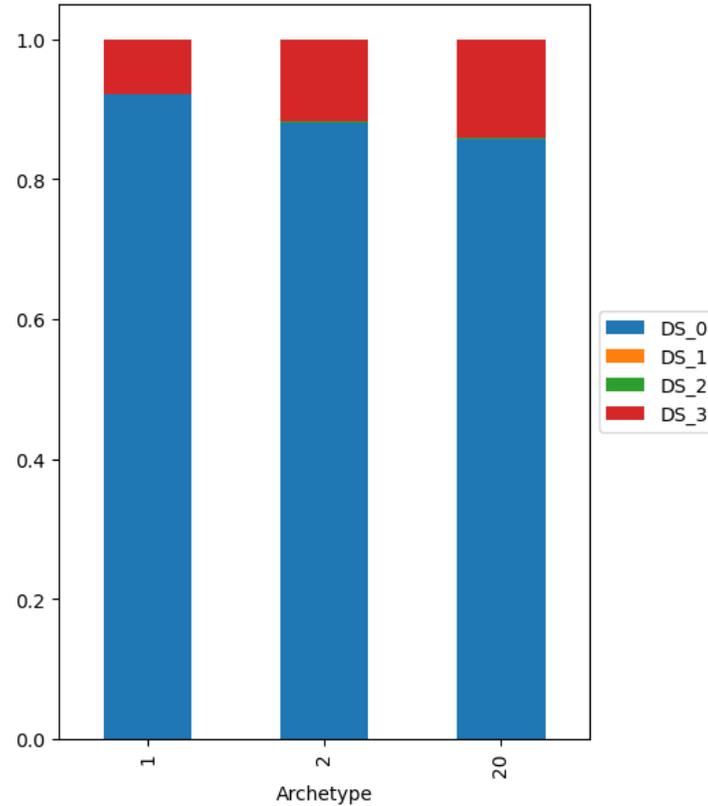


Sneak Peek – 2D Modeling

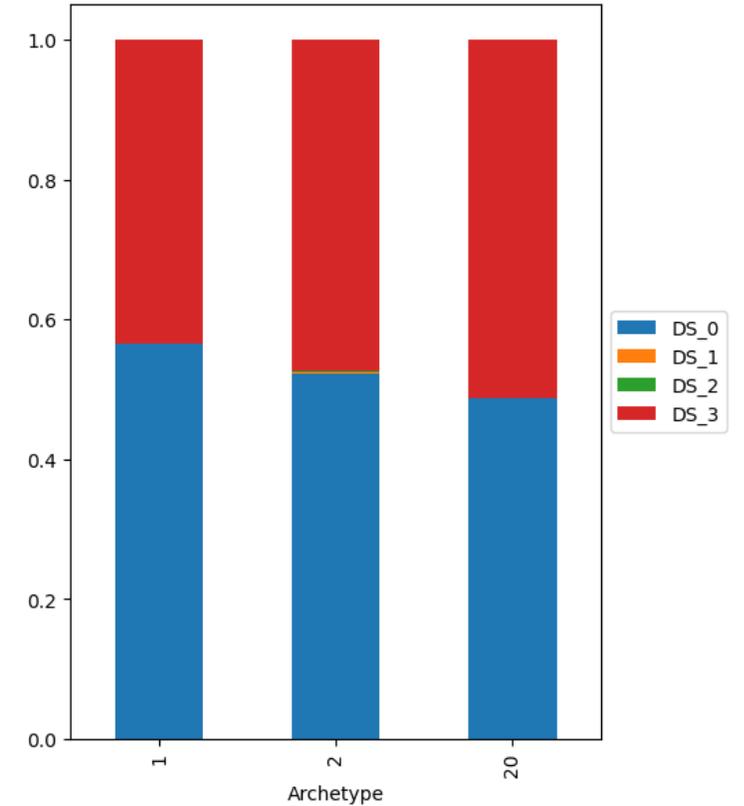
Stacked Bar Chart of Damage State Grouped by Archetype Type in 100yr event



Stacked Bar Chart of Damage State Grouped by Archetype Type in 100yr event - SLC1



Stacked Bar Chart of Damage State Grouped by Archetype Type in 100yr event - SLC2



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

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(251) 591-0588**

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