

Modeling storm surge flooding with community-informed adaptation on barrier islands

Sarah Grace Lott

J.C. Dietrich, E.L. Seekamp, A.J. Ross

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NC STATE UNIVERSITY



SOUTHEAST
Climate Adaptation Science Center

Barrier islands are vulnerable to storm surge flooding



Flooding at Hatteras Village, NC during Hurricane Dorian (2019)



Dauphin Island, AL after Hurricane Katrina (2005)

What storm surge flooding risks do communities care about?

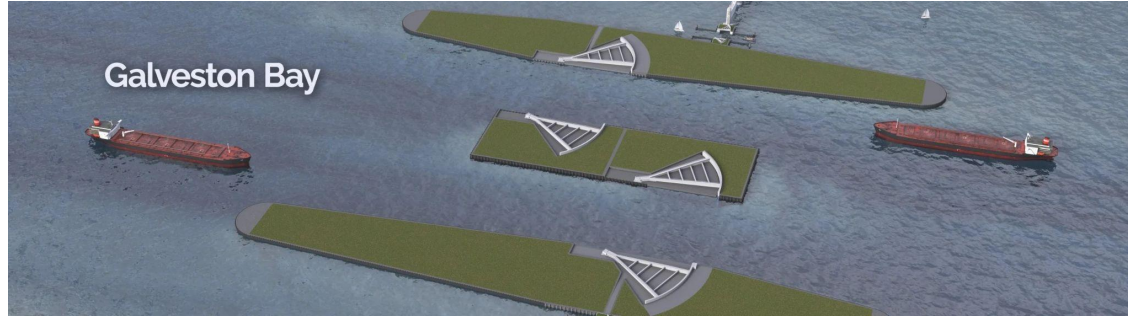


Connie Leinbach 2019



Don Bowers 2025

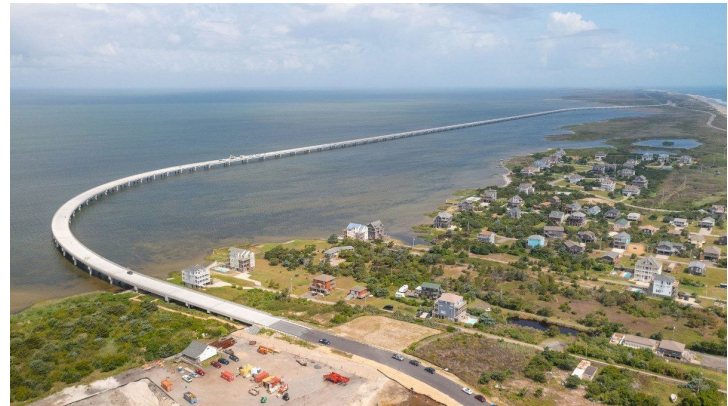
Barrier island communities are adapting to prevent flooding



Rendering of Storm Surge Barriers in Galveston Bay
Gulf Coast Protection District



Sea wall in NJ installed after Hurricane Sandy,
Mott Macdonald 2014



Bridge built around dunes prone to breaching on Hatteras Island,
Flat Iron Corps 2022

Barrier island communities are adapting to prevent flooding



Sand bagging along breached dune on Ocracoke Island
NCDOT 2025



Beach Nourishment on Hatteras Island
Coastal Science & Engineering 2022

How can communities design adaptations to fit their needs?

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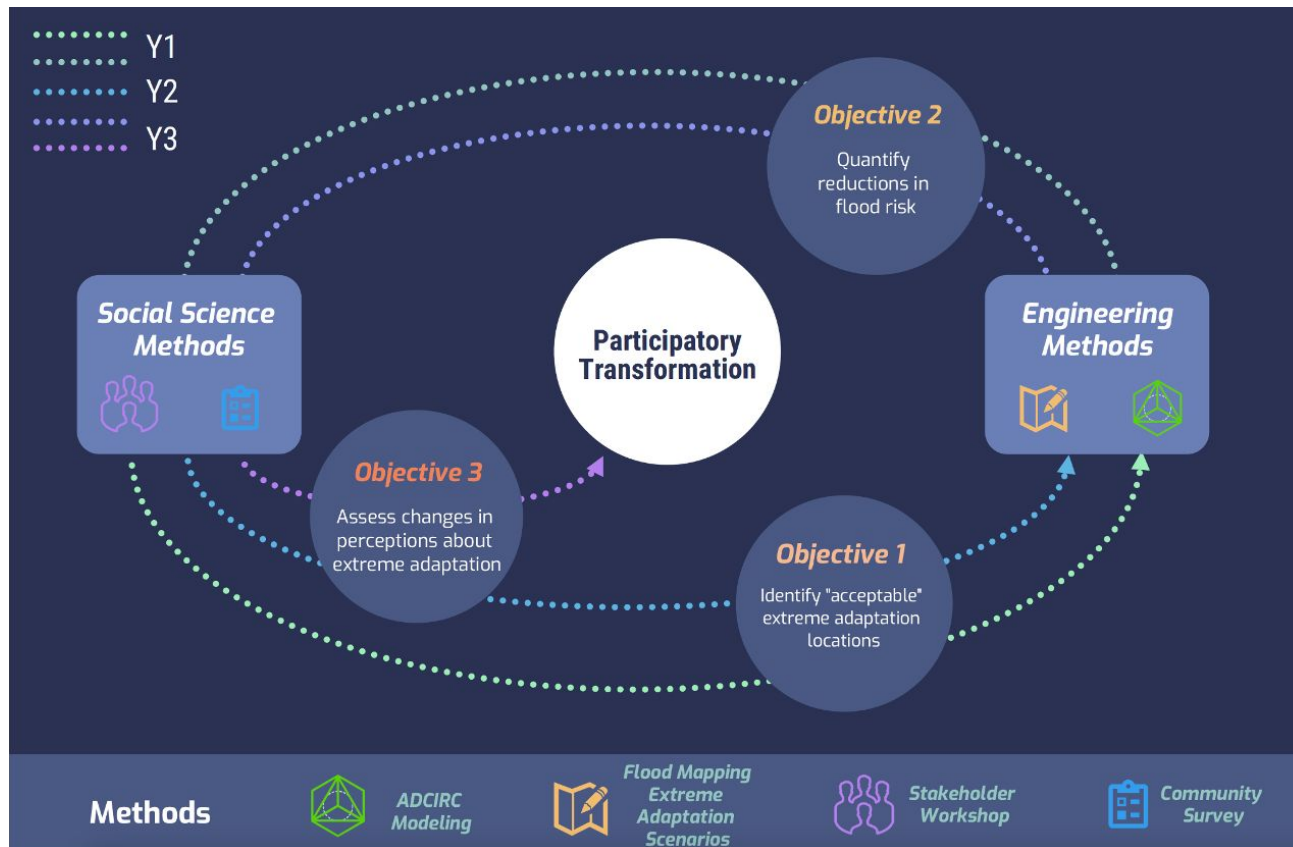
College of
Natural Resources



Dr. Erin Seekamp



Andrew Ross



Community Engaged Research



Community Engaged Research

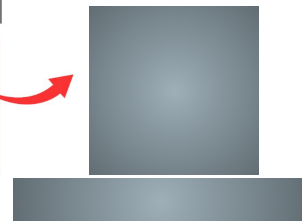
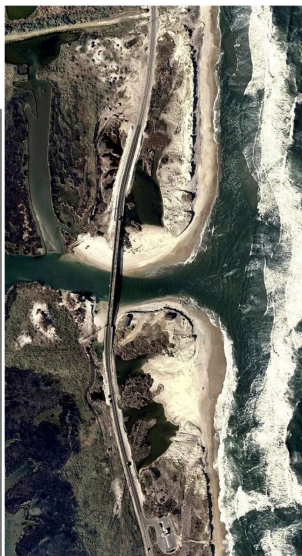
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This survey was created by researchers at North Carolina State University. You may have taken a survey with us last year (March-April 2025). This survey is different.

This study aims to understand the relationships between residential connections and preferences for adaptation strategies that may reduce future storm-related flooding on Hatteras and Ocracoke Islands.

To take the survey, please scan the QR code or type the URL into your browser. The average completion time is 10-15 minutes.

We want to hear about your connections to the place where you live and how possible adaptations can change your risk to storm-related coastal flooding!



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You will now view a visualization showing potential storm and flood impacts on the community of **Buxton**.

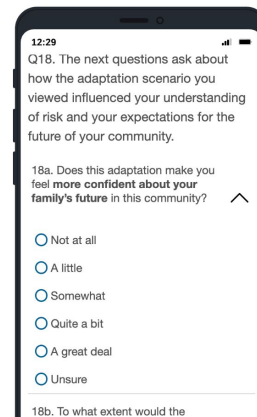
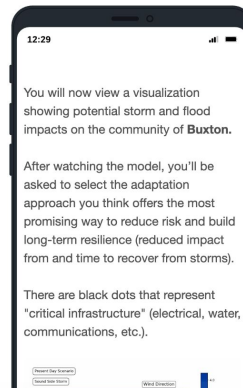
After watching the model, you'll be asked to select the adaptation approach you think offers the most promising way to reduce risk and build long-term resilience (reduced impact from and time to recover from storms).

There are black dots that represent "critical infrastructure" (electrical, water, communications, etc.).



Q18. The next questions ask about how the adaptation scenario you viewed influenced your understanding of risk and your expectations for the future of your community.

	Not at all	A little	Somewhat	Quite a bit	A great deal	Unsure
18a. Does this adaptation make you feel more confident about your family's future in this community?	☐	☐	☐	☐	☐	☐
18b. To what extent would the adaptation enhance your community's resilience (reduced impact from and time to recover from storms)?	☐	☐	☐	☐	☐	☐
18c. How much did this adaptation reduce your concerns about needing to relocate in the future?	☐	☐	☐	☐	☐	☐



Can adaptations help protect what communities value?



NCDOT 2019



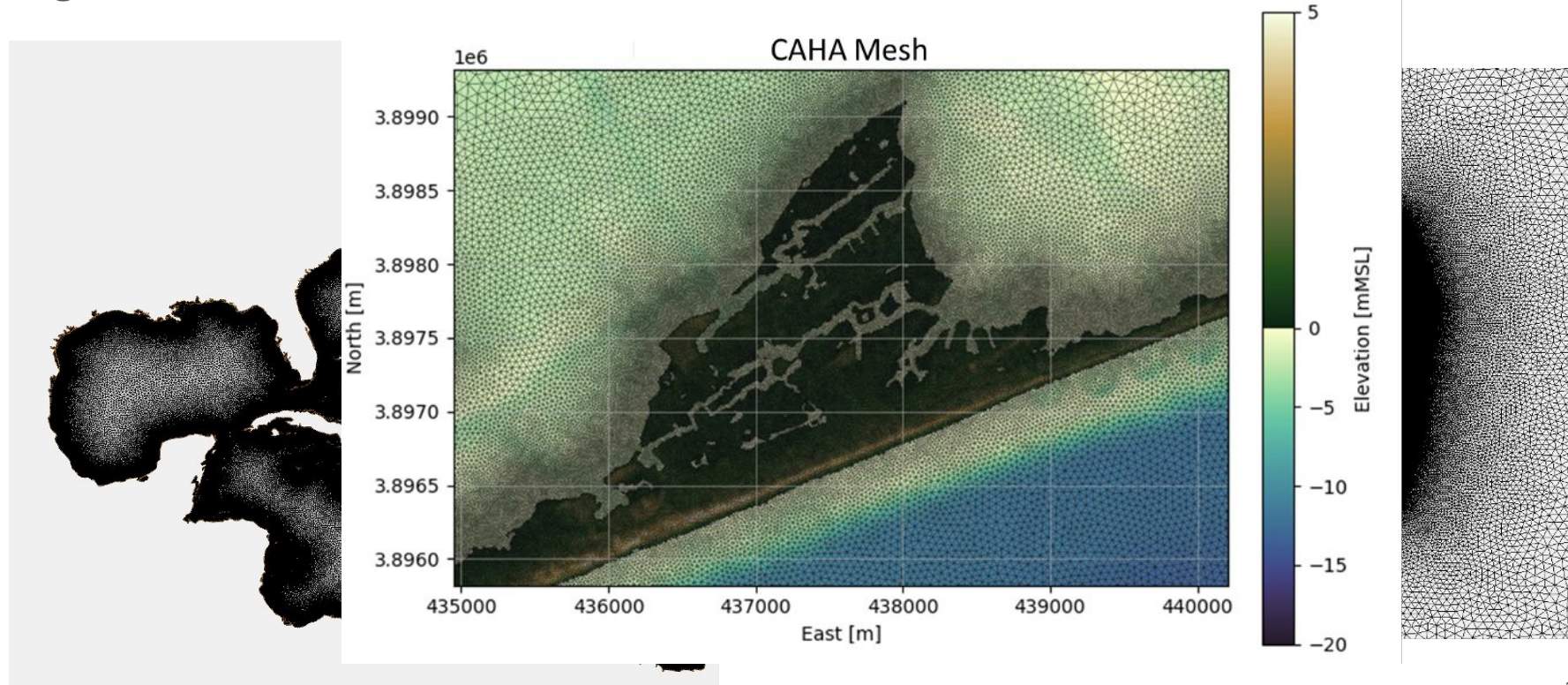
NCDOT 2025



NCDOT 2025

Modeling Approach to Problem

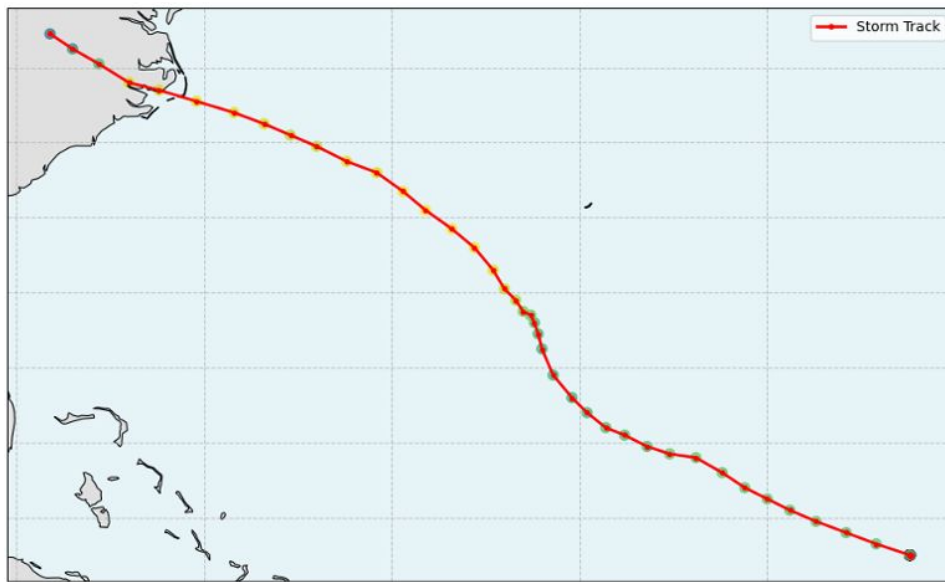
High Resolution Mesh



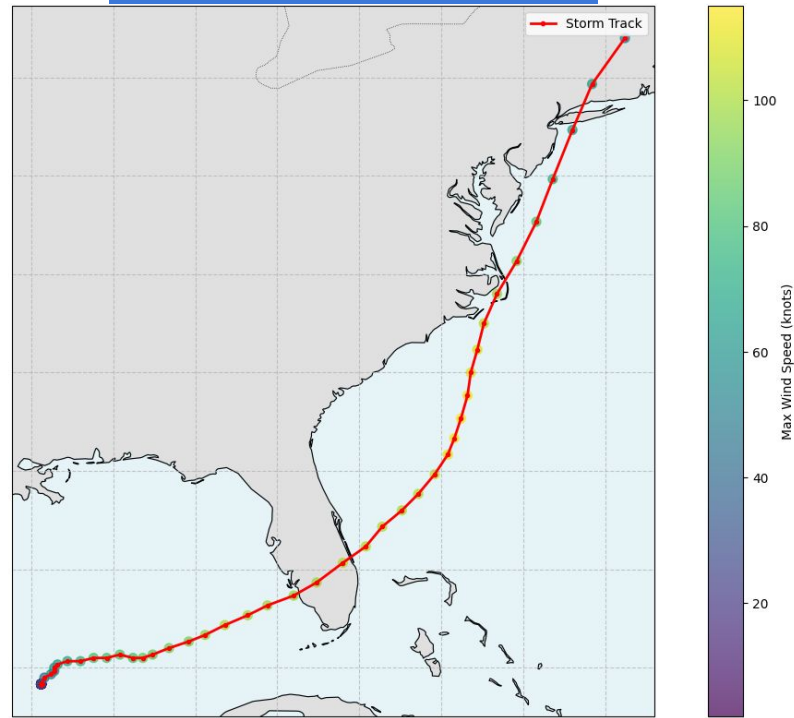
Community informed storm selection

Synthetic Storms (Bloemendaal et al., 2020)

Storm 1: Shore Perpendicular



Storm 2: Shore Parallel



Community informed adaptation selection

Baseline: No Adaptation

Bridge and Island Breach

Large Scale Nourishment

Repeated Marsh Thin Layer Placement

Raised Bulkheads and Road Levee

No Adaptation

Raised Marsh Elevation

Raised Road and Bulkheads

Triple-Scale Nourishment and
Oceanfront Property Purchase

Bridge around Hotspot and
Dune Breach

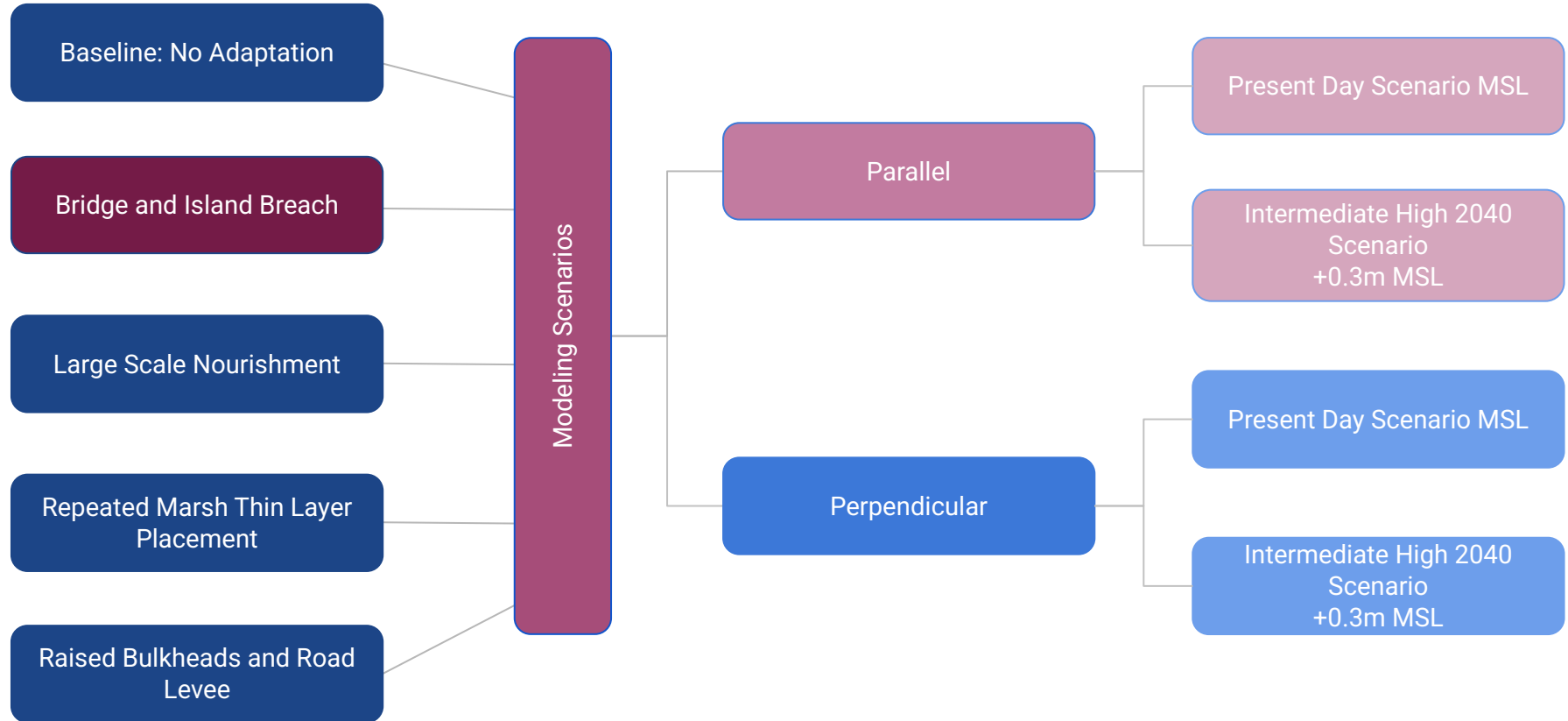
Present Day Scenario MSL

Intermediate High 2040
Scenario
+0.3m MSL

Present Day Scenario MSL

Intermediate High 2040
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+0.3m MSL

Community informed adaptation selection

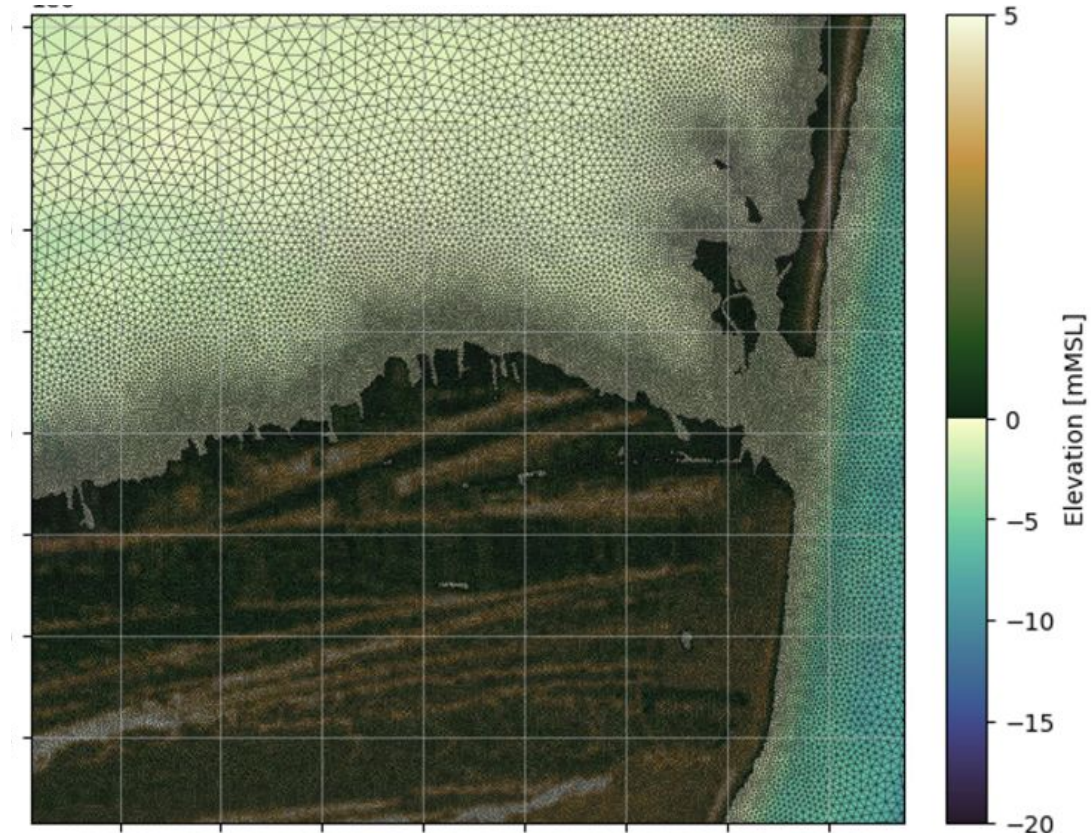


Engineered and management adaptations can protect community priorities

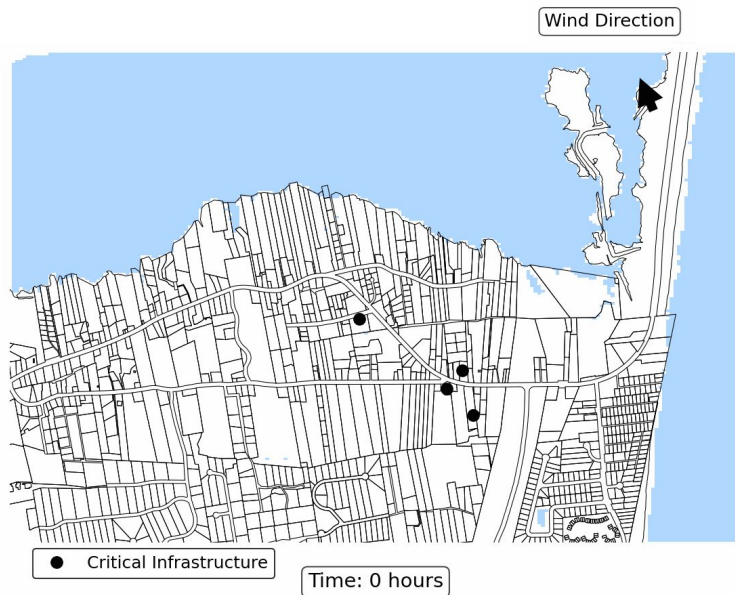


Designing Adaptation Scenarios

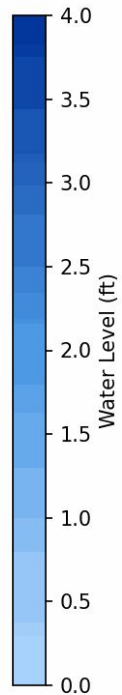
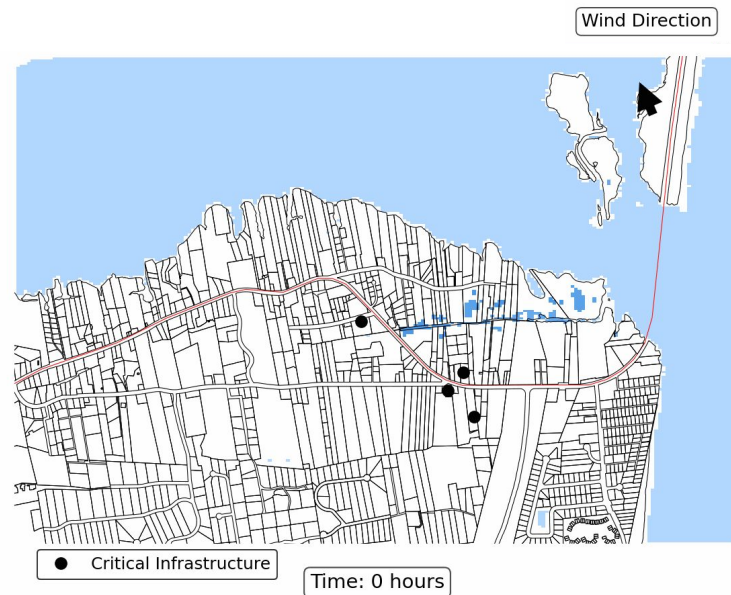
Breach at Buxton



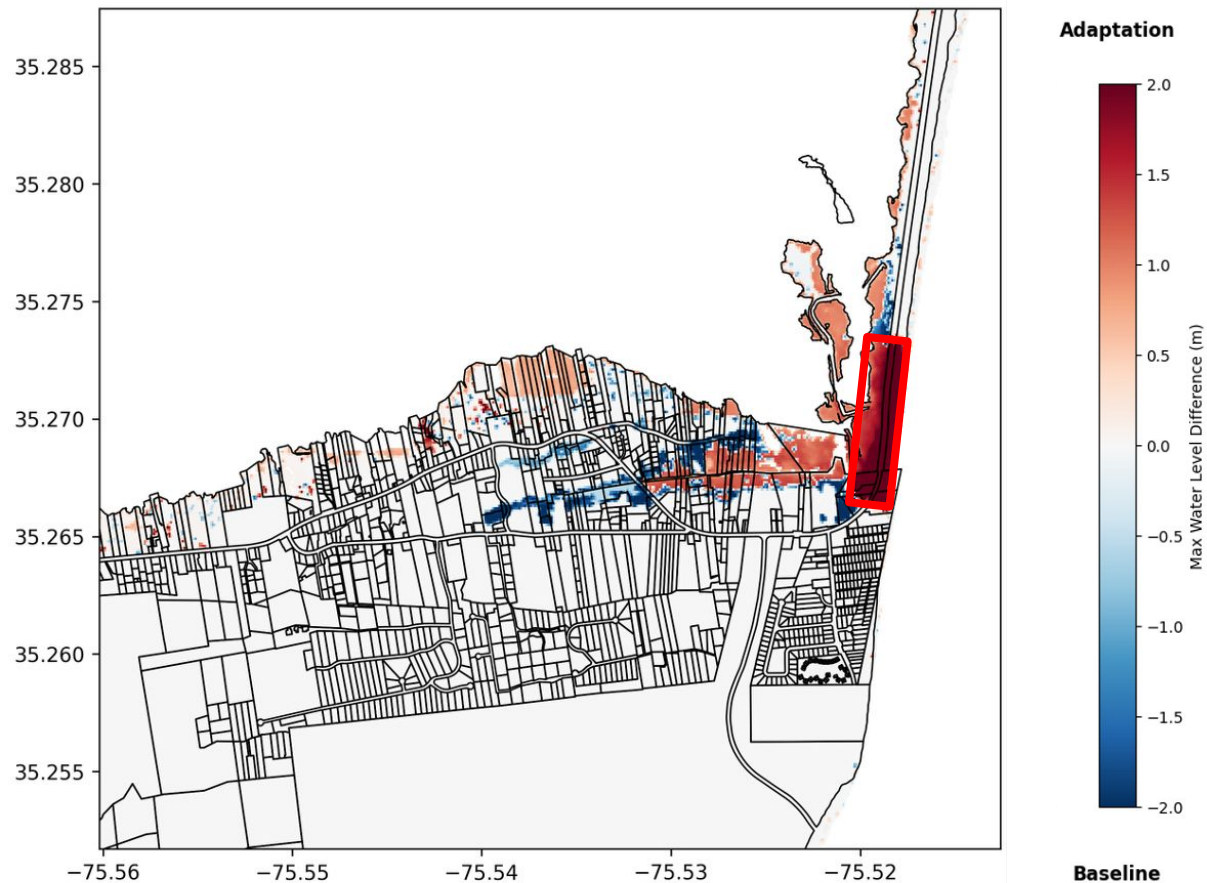
No Adaptation

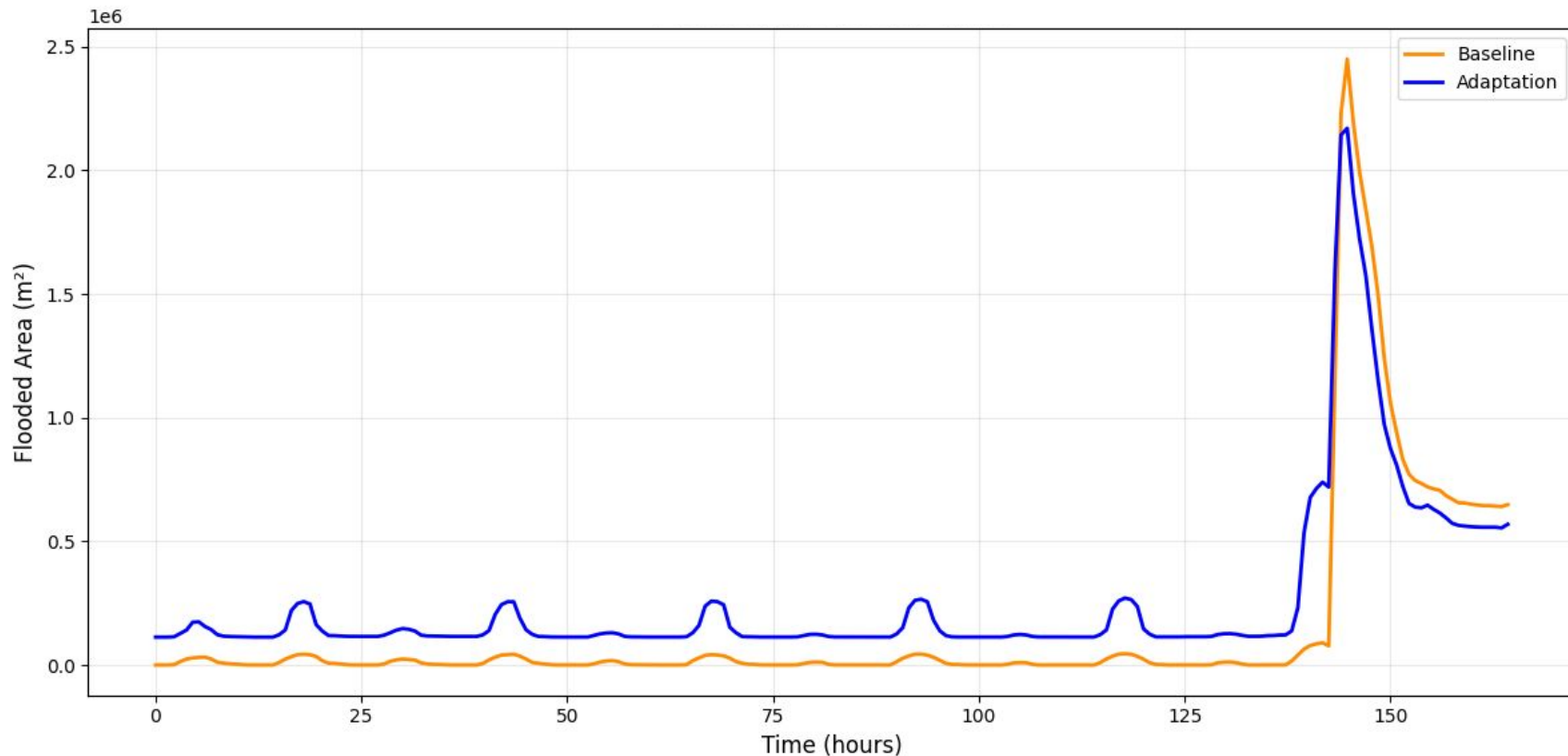


Bridge and Breach

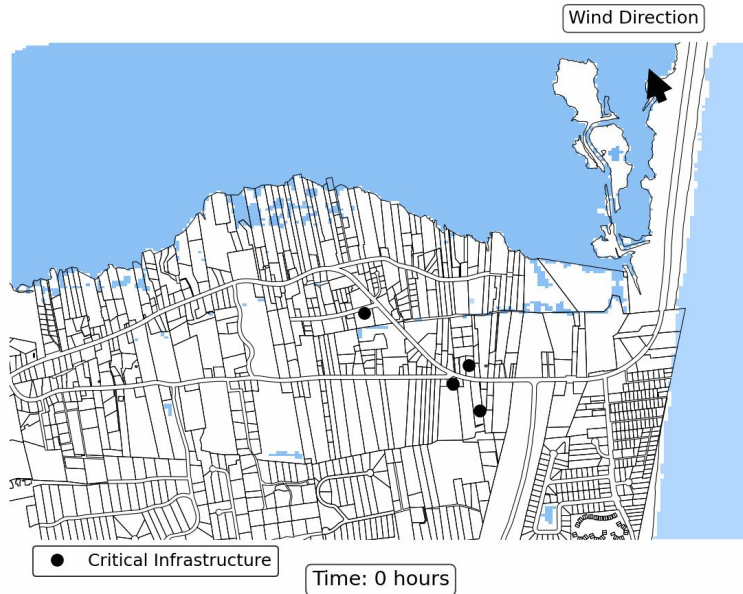


Maximum Difference of Flood Height

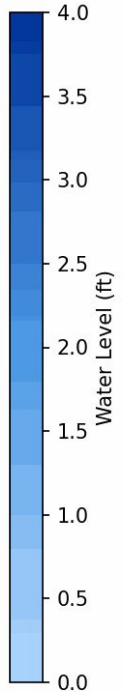
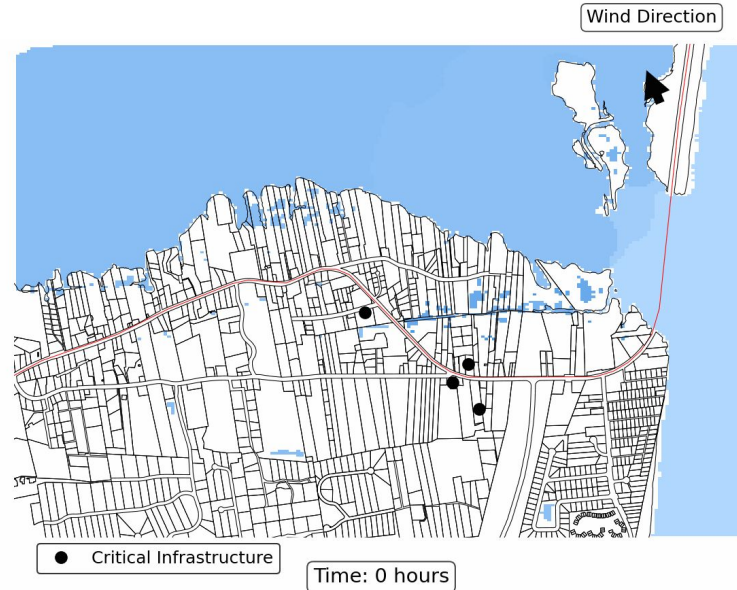




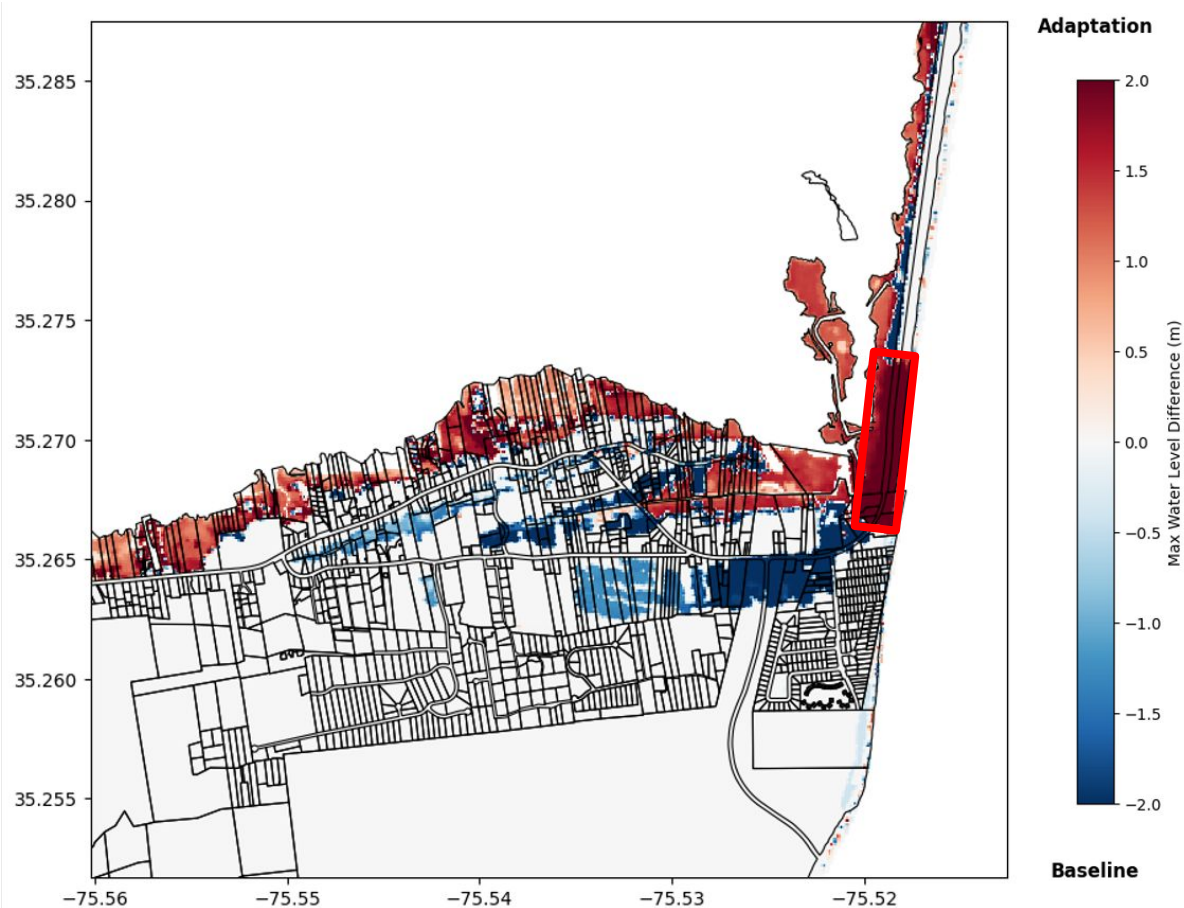
No Adaptation



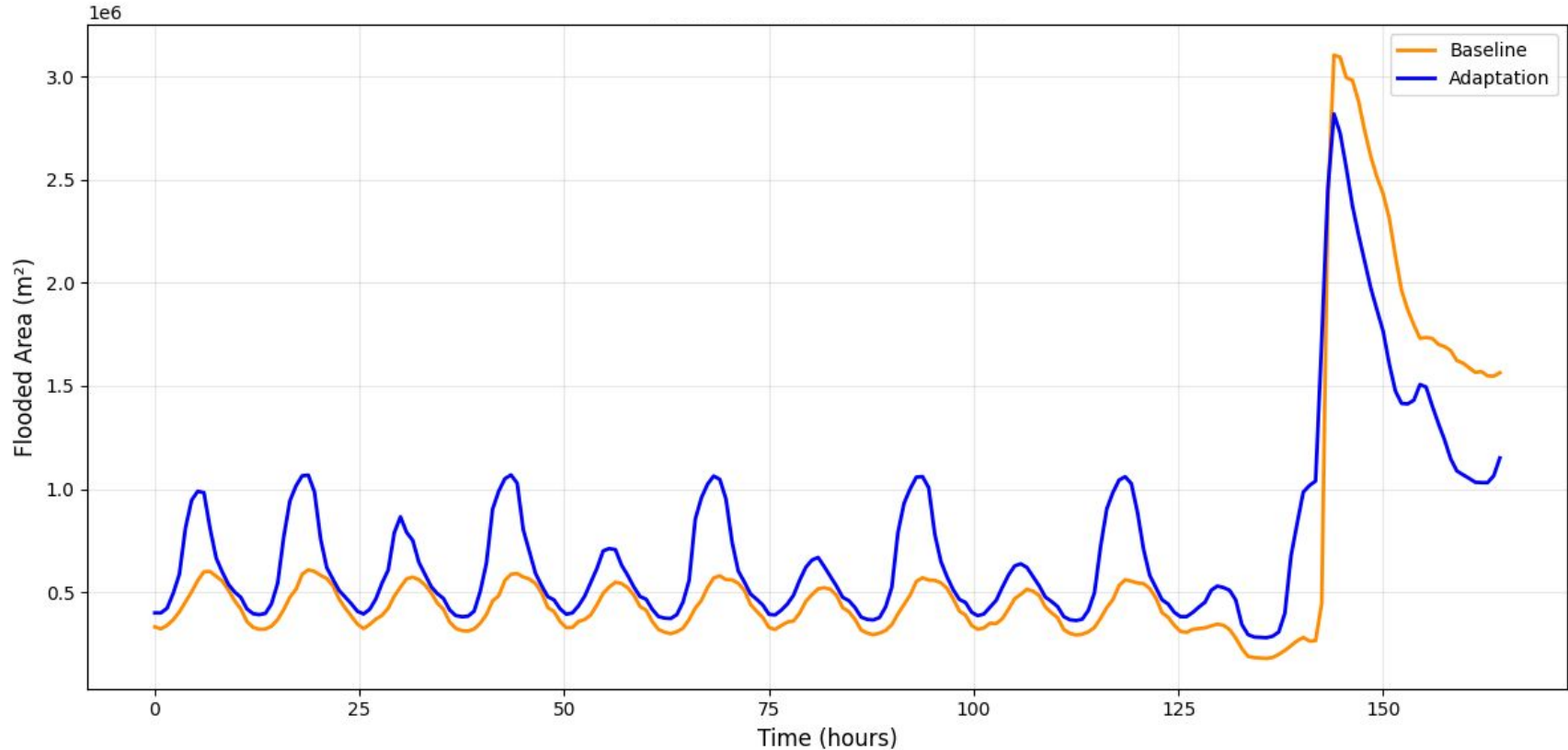
Bridge and Breach



Maximum Difference of Flood Height



Flood Area over Time In Buxton



Conclusions

- The bridge-breach adaptation under different storm scenarios has a complex effect on flooding within neighboring communities.
- Working with coastal residents to inform research questions and interpret results can lead to more impactful research design and provide meaningful results to communities.

Next Steps:

- Model a set of realistic hurricanes for each adaptation to understand overall adaptation effectiveness.

Community response to results is ongoing

April-May 2026: Community survey released

- Analysis of results underway

October 2026: Community meetings with southern Outer Banks long-term residents

- Share findings about adaptations and community resilience to flooding
- Discuss results in informal setting outside of survey