

# Assessing Coastal Hazards with SLR and Predicting Long-Term Shoreline Changes Along Beach Barrier Systems of The New England Coastline, USA

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## INTRODUCTION

Coastal barrier systems act as “ecosystem engineers” (EE), naturally adapting to slowly evolving sea level rise (SLR) and wave climate by regressing or transgressing. These systems adjust their morphology in response to short-term storm events and long-term changes in mean sea level and wave climate, maintaining an equilibrium between wave forcing and shoreline morphology. While predicting short-term shoreline changes due to storm events can be done with reasonable accuracy using 2DH hydro-morphodynamic models such as XBeach, predicting long-term changes is more challenging and affected by larger uncertainties. However, both accelerated SLR and more broadly climate change increase the vulnerability of coastal communities, despite even larger uncertainties, and such predictions are becoming increasingly important.

We investigate long-term shoreline changes along selected sections of the New England coast in the United States, using the shoreline simulation model ShorelineS, developed at IHE and Deltares, The Netherlands (Roelvink et al., 2020), combined with local observations (Oakley, 2021). Three beach barrier systems, each characterized with specific morphological dynamics, are selected to be used as calibration, validation, and verification sites, namely, Napatree Point at Westerly, Rhode Island (RI), the Ninigret-Trustom pond beach barrier system along the RI south shore, and the Atlantic shoreline of Cape Cod, MA.



Fig. 1: Study sites along the US East Coast

## METHODOLOGY

While previous studies assessed coastal risk from extreme storms in New England (Grilli et al. 2020) most of these predictions associated with storm events in the next 30 to 100 years only included a simple 'bathtub

assumption' of shoreline change, with a few exceptions introducing a parametrized shoreline recession rate algorithm based on historical data and Brun's law to refine the expected shoreline change with SLR (Grilli et al., 2017). The shoreline model, ShorelineS, has significantly improved that conceptualization. When providing the local wave climate time series, an initial shoreline configuration, and local sediment characteristics, ShorelineS simulates the main processes responsible for long-term shoreline changes at a decadal scale, including longshore current, SLR, and overwash, and the efficiency of mitigation measures can be assessed.

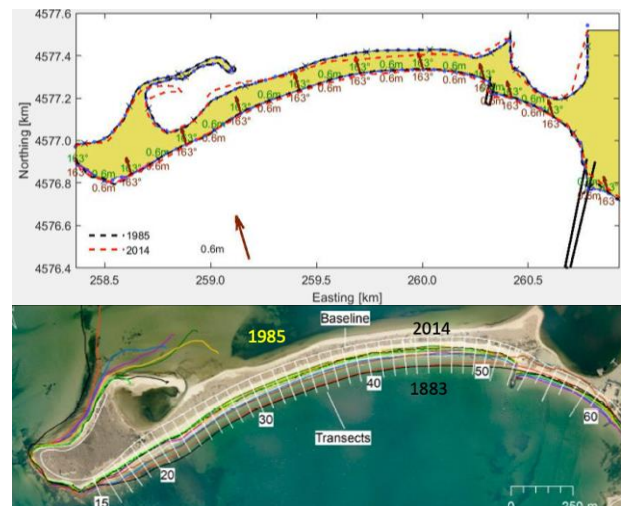


Fig. 2: Top: Simulation of the shoreline changes from 1985-2014 at the Napatree Barrier, RI, USA; Bottom: shoreline observations from 1883-2014 (Oakley, 2021).

The objectives of this study are to: (1) calibrate and validate the 1D shoreline model ShorelineS at our sites, using historical data [about 80 years of shoreline positions]; (2) use the calibrated/validated model to simulate long-term shoreline changes expected over the next decades, including SLR scenarios; and (3) assess the change in coastal risk associated with extreme storms, when including the long-term change in shoreline position. The latter compares storm impacts using the morpho-dynamic model XBeach, with or without long-term shoreline changes.

## REFERENCES

Grilli, Westcott, Grilli, Spaulding, Shi, Kirby (2020): Assessing coastal hazard from extreme storms with a

phase-resolving wave model: Case study of Narragansett, RI, USA. Coastal Engineering, ELSEVIER, vol. 16, pp.103735.

Grilli, Spaulding, Oakley, Damon (2017): Mapping the coastal risk for the next century, including sea level rise and changes in the coastline: application to Charlestown RI, USA. Natural Hazards, SPRINGER, vol. 88, pp. 389-414.

Oakley (2021): Storm Driven Migration of the Napatree Barrier, Rhode Island, USA. Geosciences, MPDI, vol. 11, pp. 330.

Roelvink, Huisman, Elghandour, Ghonim, Reyns (2020): Efficient Modeling of Complex Sandy Coastal Evolution at Monthly to Century Time Scales. Frontiers in Marine Science, vol. 7, pp. 535.