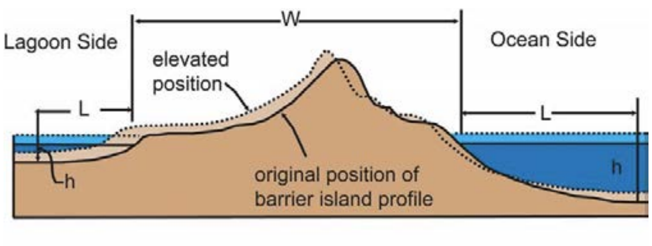
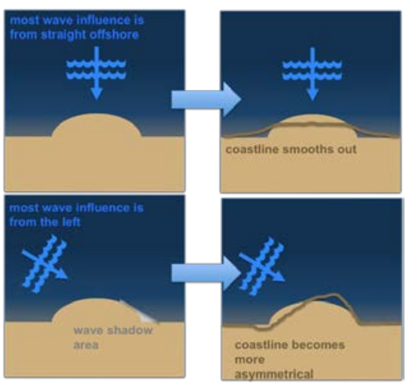
Coastline Change App: Future Scenarios

Numerical models provide a way for coastal scientists to explore different scenarios, or possible combinations of processes. In the future, we don't know exactly where the barrier islands will be or what shape they will have, but this tool is a step toward figuring out how certain processes could combine to affect the future of barrier islands and their coastlines. This model uses the Virginia Barrier Islands as the starting point, but doesn't reproduce this coast in detail. It is useful for exploring how rates of coastline change might shift in response to three specific processes:

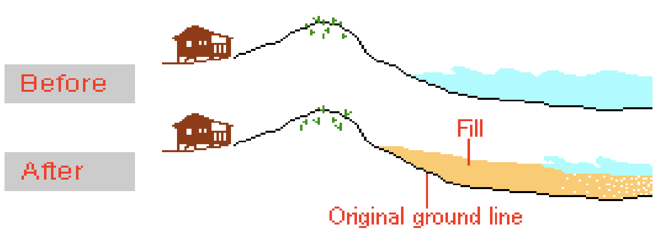
1. **Relative Sea Level Rise**
Sea level rise can cause barrier islands to grow taller and migrate back toward the mainland as long as they can get enough sediment to maintain elevation.





2. Shifts in Wave Climate
The wave climate, the average behavior of waves over many years, affects patterns of coastline change rates. Wave climate includes a number of factors relevant to sediment transport including the angle waves are approaching from and the height of the waves. If storm frequency or intensity changes because of climate change, the influence of waves approaching from a certain direction will also change.

3. Beach Nourishment
Humans sometimes respond to changing coasts with modifications of their own. In this app, you'll be able to explore the effect that modeled beach nourishment at two specific locations has on the rate of coastline change.



Future Scenarios of Coastline Change included in Coastline Change App

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Overview

Using a simulation of the Virginia coast, a first-of-its-kind model was used to make reasonable estimates of how shorelines might move in the future. To do this, the model extrapolates from the best scientific understanding about processes that contribute to shoreline movement, such as erosion, transportation, and deposition of sand. With more frequent and intense storms expected in the future, waves and currents in combination with sea level rise are expected to strongly influence the way that shorelines move. In addition, a likely response to these changes is beach nourishment of shorelines where possible like at Wallops Island.

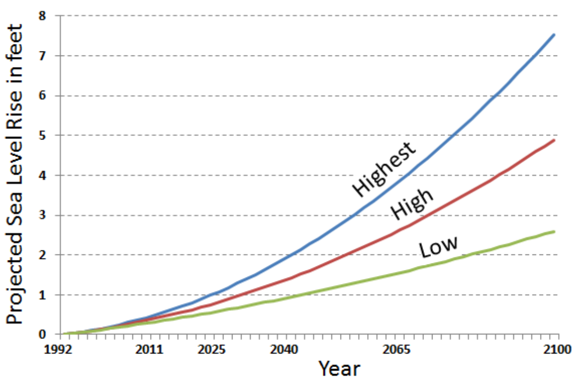
By comparing the difference between the base case and experimental future scenarios, this app helps identify climate and nourishment scenarios that are likely to cause shifts in the rates of shoreline change. The results are presented as the *shoreline change rate difference* (SCRD) in either landward or seaward movement. Although this information cannot be used to identify specific shoreline positions at future points in time, it does support the exploration of different regional climate and nourishment scenarios in order to better estimate and manage shoreline changes.

The Selection of Scenarios

A scenario is climate and/or a human-made change that might affect shoreline change rates. A total of 36 future scenarios were modeled for the app that include three sea-level rise scenarios, four wave climate scenarios, and three beach nourishment scenarios, and the various combinations of sea-level rise with wave climate and nourishment. Specifics of each scenario for sea-level rise, wave climate, and beach nourishment are described below.

Description	Number of Scenarios
Sea Level Rise Only	3
Sea Level Rise + Wave Climate Change	6
Nourishment + Sea Level Rise	9
Nourishment + Sea Level Rise + Wave Climate Change	18
	Total: 36

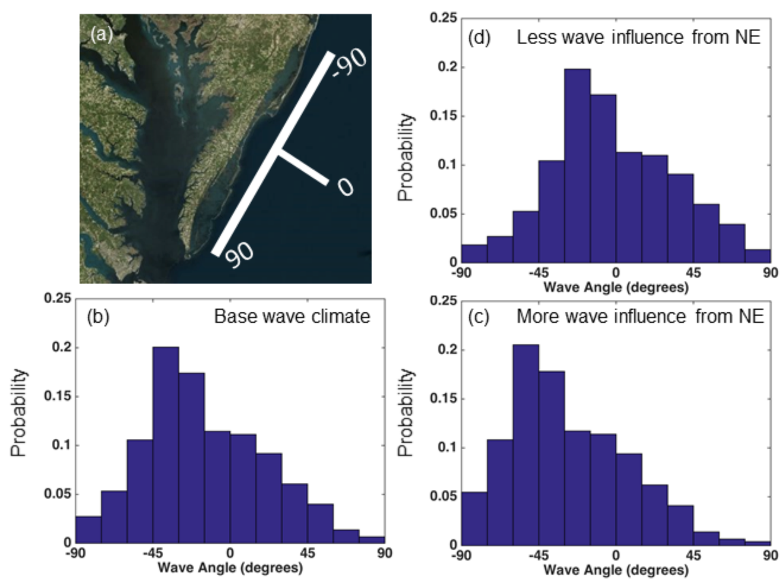
A. **Sea-level rise**. Sea-level rise scenarios are based on based on the 2012 National Climate Assessment and have been customized for Virginia by the Virginia Institute of Marine Science. The three sea-level rise scenarios modeled that were selected by stakeholders are:



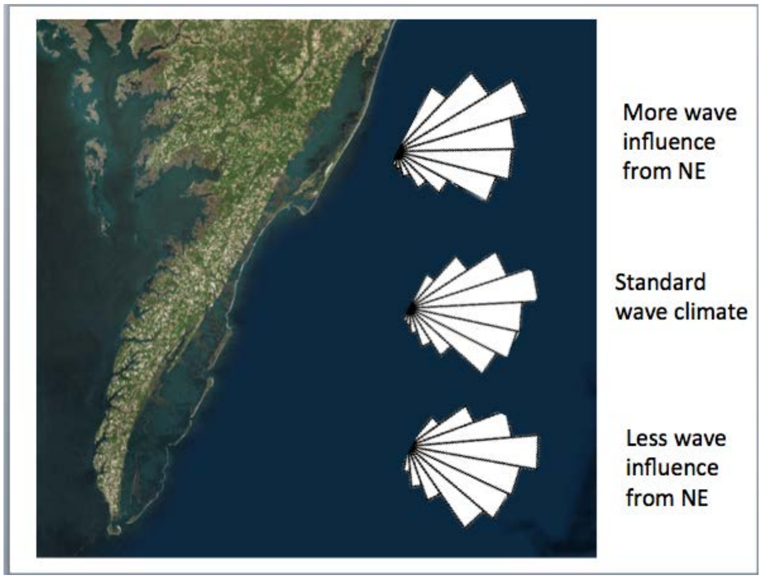
1. The "low" scenario is based on the Intergovernmental Panel on Climate Change 4th Assessment model using conservative assumptions about future greenhouse gas emission (the B1 scenario).
2. The "high" scenario is based on the upper end of projections from semi-empirical models using statistical relationships in global observations of sea level and air temperature. This is currently seen as the most likely scenario by scientists.
3. The "highest" scenario is based on estimated consequences from global warming combined with the maximum possible contribution from ice-sheet loss and glacial melting (a practical worst-case scenario based on current understanding).

B. **Wave Climate:** Climate change is likely to lead to increases in hurricane intensity or increases in the frequency of the most intense hurricanes. This affects patterns of coastal erosion and accretion by altering the prevailing wave climate (specifically wave height and angle of approach). Two potential future wave climates were considered to estimate the effect that changes in storm intensity could have on patterns of shoreline change. These wave climates were created by adjusting the best known present wave climate to reflect either a greater or lesser proportion of waves approaching from the northeast. The three wave climate scenarios modeled in the app are:

1. No change; present wave climates stays the same in future.
2. Shift to northeast by 15 degrees from present wave climate
3. Shift to southeast by a 15 degrees from present wave climate].



or



C. **Beach Nourishment**: Based on stakeholder input, two zones corresponding roughly to sites on Assateague Island and Wallops Island were identified as areas where beach nourishment may take place in the future. To estimate the effects of nourishment, the model considered a 2 km stretch of beach as the nourishment zone for Assateague and a 4 km stretch for Wallops. The model assumes that (1) nourishment is done every year and the amount of sand added will be exactly the right amount to maintain the shoreline position, (2) that the sand used for nourishment comes from far enough away that removing it doesn't affect the coastal response, and (3) that nourishment will continue for the entire model run regardless of cost. These projections represent hypothetical future scenarios which are intended to supplement the respective landowners' decision-making processes. Beach nourishment was modeled only for those areas where it has occurred in the past (Wallops only) or may be considered in the future (Assateague), ***but the modeled projections should in no way indicate an endorsement of any management option, either in those areas or elsewhere in the region.***

(Placeholder for map that shows the zones of nourishment]

Potential Inlet Openings

Tidal inlets are openings in the shoreline connecting the ocean to bays, lagoons, or marshes. On barrier islands that have been thinned by erosion on their ocean shoreline, inlets may form during storms when waves overtop the island's foredune system and push water and sediment to its bay side, effectively cutting a channel. Whether an inlet remains open depends on the volume of water flowing into and out of the channel during the tidal flood and ebb cycles. This process is represented in the model, yet the time and spatial resolution of the model experiments does not allow for explicit predictions of where and when inlet openings occur. Instead, at the end of each 50-year experiment island height is measured at each shoreline location. Areas showing enhanced potential for inlet opening correspond to model scenarios resulting in low island elevations.

Placeholder for map showing potential inlet openings

Definitions:

> **Base case scenario:** A base case scenario models future change under current climate conditions: 3 mm per year of sea level rise, a wave climate consistent with the best-known present wave climate, and no nourishment at any locations.

Shoreline Change Rate Difference (SCRD): The shoreline change data are the average difference in shoreline change rates between the base case scenario and the experimental scenario. A negative SCRD indicates that the experimental scenario results in more erosion or less accretion relative to the base case, whereas a positive SCRD indicates that the scenario results in more accretion or less erosion relative to the base case.

Wave Climate: Wave climate refers to an estimate of the long-term average wave conditions at a given location. Typical properties considered in wave climate estimates include wave height, period, direction, and energy. The wave climates presented here represent the directional distribution of wave energy relative to the large-scale shoreline trend.

Commented [1]: Still probably needs work, maybe to be less jargony. Is the amount of info ok, or should we elaborate?

Others?

Further Information

Place holder:disclaimer that explains once this work is peer reviewed and published, it will be posted…..also need to provide contact information for team if people want further information in the meantime.