Simulating Dune Evolution on Managed Coastlines: Exploring Policy Options with the Coastal Recovery from Storms Tool

Motivation and Community Need

Coastal foredunes provide critical ecosystem services; they are the first line of defense against flooding, provide conservation value for native species, and are a major draw for recreation and tourism. However, dunes remain highly vulnerable to both climatic (e.g., sea level rise, changes in storminess) and anthropogenic (e.g., reduced sediment supply, trampling of vegetation) pressures. Despite the importance of dunes to many low lying coastal communities, our understanding of how these pressures affect the viability of foredunes on time scales of relevance is particularly poor. Only recent advances in numerical modeling have enabled predictions of both progradational and erosional morphodynamics, including the growth of dune systems during calm periods and their erosion during storms.

Here we introduce the **C**oastal **R**ecovery from **S**torms **T**ool (**CReST**). **CReST** is a graphical user interface which aims to expand the capabilities and usability of **Windsurf,** a process-based numerical modeling system which simulates the evolution of dune-backed sandy coastal systems in response to both wave and wind forcings, to better account for the complex dynamics of managed coastlines. The ability to incorporate dune grass planting scenarios, beach nourishment and dune construction, beach scraping, dune grass removal, and the presence of hard engineering structures into **CReST/Windsurf** provides a new research tool to explore the implications of management decisions on coastal vulnerability (Fig. 1).

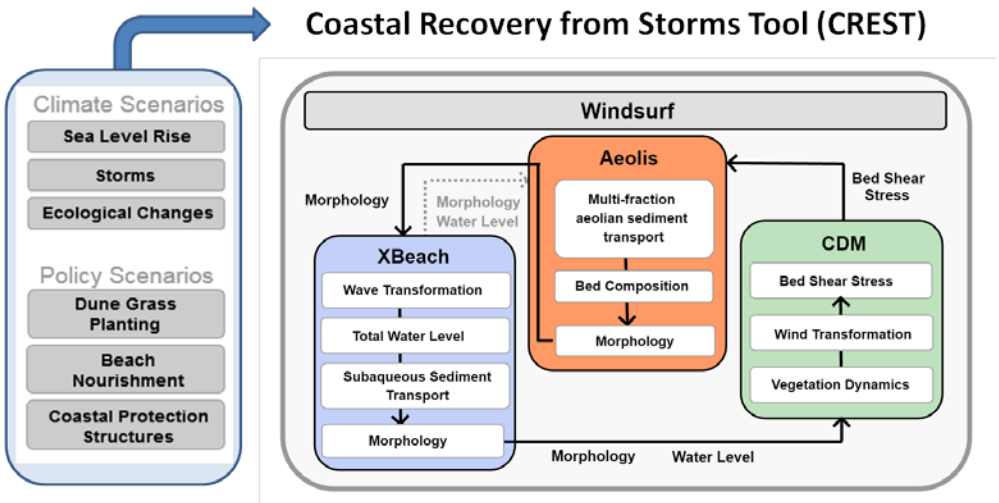

Figure 1. Schematic representing the general **CReST** framework which includes the coupled model **Windsurf** at its core with three standalone numerical models (XBeach, Coastal Dune Model, Aeolis).

Approach

Using the **Windsurf/CReST** modeling system we are exploring optimum beach nourishment strategies which (1) promote the natural development of dunes and (2) have the longest project lifecycles (Figure 2). Additional targeted modeling questions are being developed in conjunction with local stakeholders at study sites in Bogue Banks, NC and in the US Pacific Northwest in order to help guide effective and economic management strategies for beach/dune nourishment and vegetation planting campaigns.

Figure 2. Examples of (a) grass planting, (b) grass removal, (c) beach nourishment, (d) beach scraping, and (e) coastal protection structures incorporated into **CReST.**

Findings/ Benefits

Windsurf is a new open-source coupled numerical modeling framework capable of simulating the co-evolution of the nearshore, beach, and dunes. Consistent with field measurements, recent **Windsurf** applications have shown skill at simulating coastal change by winds and waves at time scales of hours to years. **CReST** extends the **Windsurf** model capabilities to explore implications of management decisions on coastal evolution. This in-development tool will provide a valuable asset for scientists and managers struggling to synthesize coastal evolution in response to environmental, ecological, and anthropogenic factors.

Status/Steps Moving Forward

While additional effort is required to further test the model in other settings and with other environmental cases, **CReST/Windsurf** provides a new platform to explore complex interactions between the subaqueous and subaerial zones of the coastal profile for a variety of exploratory and applied applications.

Support and Points of Contact

Development of **CReST/Windsurf** has been a collaborative effort between Oregon State University, University of North Carolina - Chapel Hill, Delft University of Technology, Deltares, IHE Delft, and Texas A&M University. This effort has been primarily supported by NOAA via the EESLR program under Grant NA15NOS4780172 with additional support via an USCRP challenge grant and the National Science Foundation under grant EAR-1561847. For more information please contact:

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