Quantification of Hybrid Dunes as a Solution for Barrier Island Resiliency

Problem

Barrier islands experience extreme sediment loss annually from elevated water levels and wave impacts following storm events, thus engineered solutions designed to mitigate these effects and limit shoreline infrastructure loss are imperative. Hybrid dunes are one potential natural-infrastructure solution, combining flood-risk protection value of traditional, "gray" infrastructure with the ecological value provided by "green" infrastructure, though these values have not yet been fully quantified. By better informing engineering and ecological performance of hybrid dunes, coastal engineers across the USACE and Nation can make informed decisions in sediment placement and coastal construction efforts, potentially reducing future costs associated with sediment and infrastructure losses following severe events.

Technical Approach

Physical modeling experiments will utilize the ERDC Coastal and Hydraulics HICERF facility to evaluate hybrid dune designs commonly being implemented by USACE practitioners and partners. The HICERF facility consists of a 0.9-m wide 45.7-m long, glass-walled wave flume which allows for the generation of random, regular, and solitary waves. Utilizing this facility, hybrid dune designs including geotextile bag core dune, honeycomb systems, rock cores, or other identified common-use designs will be evaluated under wave action. Prior to the physical model testing, the selected hybrid dune designs will be constructed, and planted with dune grasses commonly selected for coastal restoration efforts. The dunes will be grown for a minimum of 6 months within the ERDC Environmental Lab's greenhouses, to obtain vegetation establishment that is representative of a coastal dune planting effort. This experiment will investigate multiple wave conditions and water level scenarios and evaluate profile evolution over time. Data collection will include capacitance wave gauge measurements, as well as laser-scanner data for both profile evolution and wave run-up.

Following the experiments, data collected will be used to inform coastal life-cycle analysis tools such as Beach-fx. Beach-fx, the USACE certified Coastal Storm Risk Management (CSRM) tool, is used to justify massive USACE investment in beach nourishment projects. Application of armoring in Beach-fx requires the user to specify failure thresholds for varying armor types. Armoring prevents erosion damages from being incurred within the model, allowing for the evaluation of the economic benefits of armoring beaches. Thresholds are typically applied through the project engineer's best judgment. Results from the experiments will be used to update these thresholds to consider a hybrid dune application and will improve realism of future Beach-fx studies evaluating cored dunes.

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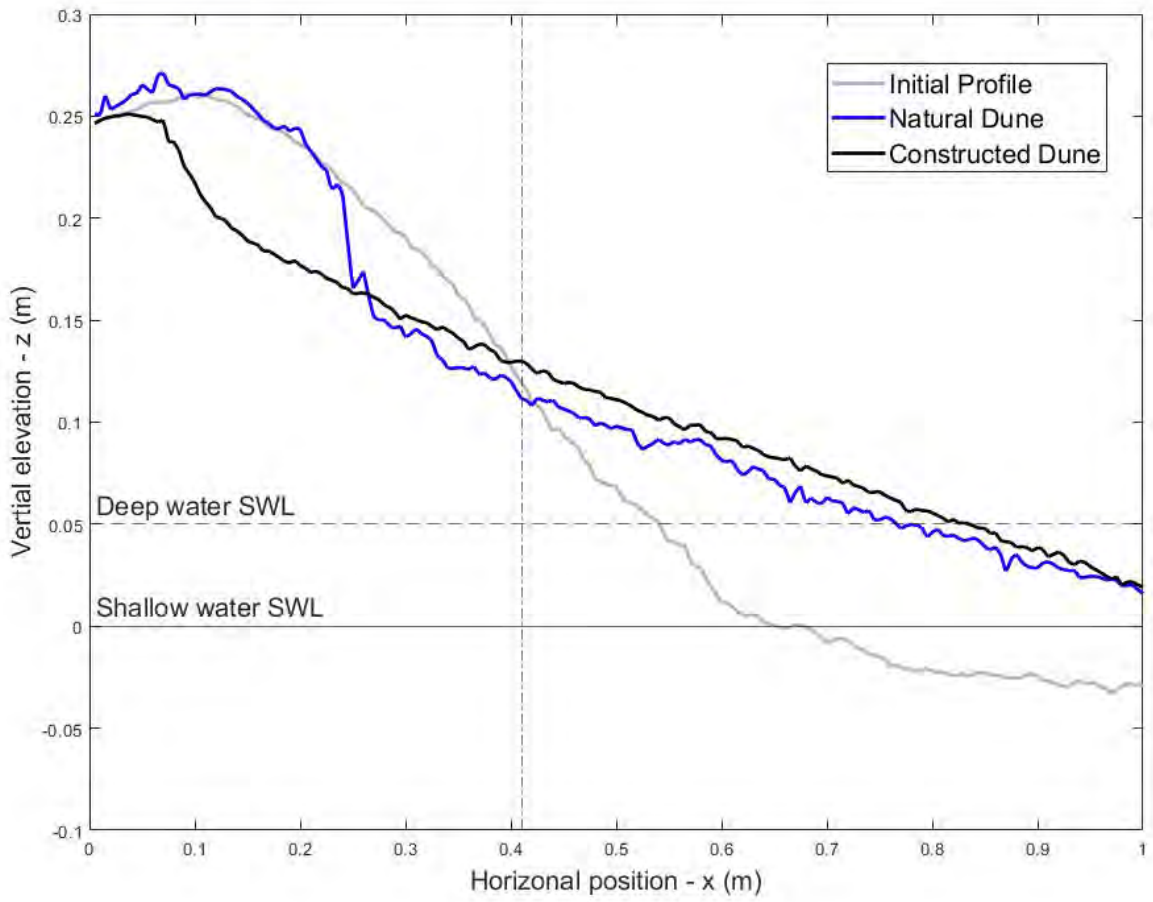
Value

This project will propose a framework for quantifying natural infrastructure solutions for coastal protection while simultaneously providing data to inform design guidance on hybrid dunes. This will ultimately allow for improved coastal design decision making by providing updated performance information, and introduce additional tools for feasibility-level planning.

Laboratory Experiments: Evolution of a Natural vs Constructed Dune



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