

Quantifying Dune Morphological Evolution on Storm to Annual Time Scales

Kate Brodie, Ph.D. Research Oceanographer Nick Spore, M.S. Research Engineer





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Motivation & Research Questions

- Importance of dunes as nature-based infrastructure that can offer protection during storms
- How can we better utilize dense lidar data sets to identify the physical processes acting on a dune?
- How does dune morphology affect rates of erosion during a storm?
- Can we better quantify (and ultimately predict) rates of natural dune recovery?





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If the physical processes acting on a dune affect its morphology, can we use detailed morphological observations to better quantify the present state of a dune?

• Problem:

- Dense lidar datasets are often under-utilized because users are often CPU & time limited
- Solution:
 - Develop automated tools to analyze & classify dune state



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Coastal Foredune State

•Convex curvature indicative of active Aeolian processes (Thom and Hall, 1991)



STORM RESPONSE: AUTOMATED ANALYSIS OF TERRESTRIAL LIDAR DEMS. Proceedings of Coastal Sediments 2015, San Diego, California.

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- indicative of recent scarping from wave attack
- No incipient dune present and often little to no • recovery at the base of the dune

Brodie, K.L. and Spore, N.J. (2015). FOREDUNE CLASSIFICATION AND STORM RESPONSE: AUTOMATED ANALYSIS OF TERRESTRIAL LIDAR DEMS. Proceedings of Coastal Sediments 2015, San Diego, California



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an unconsolidated pile of sediment

Coastal Foredune State



- Automated analysis that classifies foredune state from terrestrial lidar DEMs
- Classification can help identify regions of the coastline that are:
 - recovering naturally
 - remaining in an erosive state

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Dune Response during a Nor'Easter

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Dune Retreat Rates



- Recovering & man-made dunes eroded more rapidly than the scarped dune
 - Both recovering & man-made dunes also had lower dune toe elevations at the start of the storm
- Recovering and man-made dunes experienced an initial drop in elevation of the dune toe whereas the dune toe of scarped dunes retreated babckward & upward at a slower rate
- **Hypothesis:** unconsolidated sediment present in both the incipient recovering foredune and the mad-made dunes combined with lower D_{low} elevations yields higher erosion rates
 - Different erosion process? More swash-like than avalanching?



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Monthly evolution of an eroding & prograding dune system







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FRF North & South Dune Systems

North Dune: High (7.5m) and steeply scarped, little to no vegetation on face but thick at dune crest





South Dune: Lower (6.5m) and hummocky, vegetation present through entire dune system



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North Dune Site – Feb 6 Elevation Difference

the vent



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- 0.20

North Dune Site – Mar 25 Elevation Difference

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North Dune Site – Apr 10 Elevation Difference

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North Dune Site – May 20 Elevation Difference



North Dune Site – Jun 17 Elevation Difference

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Real Property in the second se



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-0.20

North Dune Site – Jul 15 Elevation Difference



-0.20

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RAA

Point Cloud Analysis



Profile transect drawn through point cloud data at 5 cm resolution

Over 7 month period some areas experienced ~40cm accretion on incipient dune





Stationary Dune Lidar



UNCLASSIFIED

"Joaq-easter" at the FRF



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