US Coastal Research Program (USCRP) DUNE R&D

Calibration of Coastal Dune Models using Structure-from-Motion Photogrammetry and a Genetic Algorithm

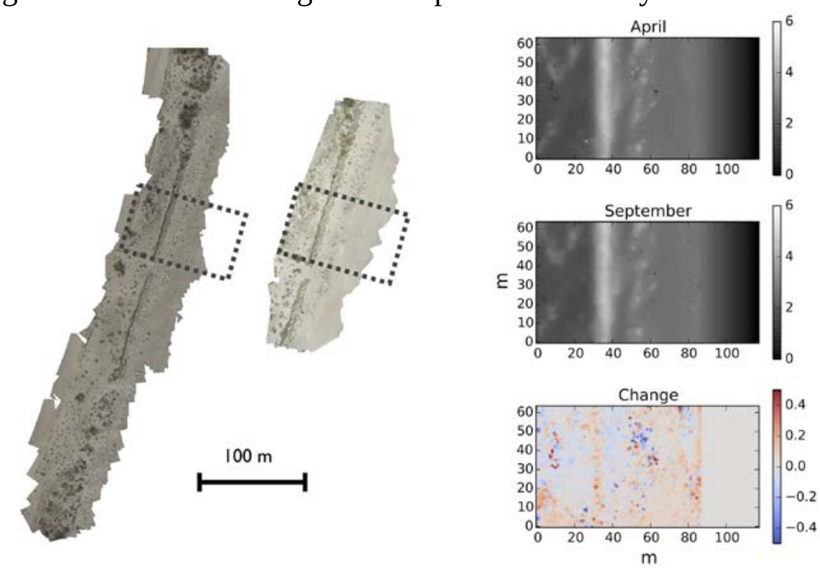
Motivation and Community Need

Coastal foredunes can reduce impacts from elevated water levels during storms and high water. Storm forecasting tools use dune parameters (i.e., height, volume) to predict storm impact, however dune topography is often not up-to-date because acquiring high-resolution topographic data before every potential storm is impractical and/or infeasible. As a result, dune growth between storms is often unaccounted for in storm impact forecasts, limiting the accuracy of storm impact predictions.

Given that regional measurements of dune topography are made only periodically, an alternative approach to predicting dune height at any given time is to use quantitative models to simulate foredune growth. Accurate numerical modeling of dune growth requires calibration of free parameters in the model. But how do we optimally tune free models when many free parameters must be adjusted?

Approach

We developed an approach for setting model parameter values using the machine learning technique of genetic algorithms. There are 3 component steps in this approach. First, we collected spatially extensive topographic and vegetation data using kite-based structure from motion photogrammetry. After processing this data we used this data in a coastal dune model (Duran and Moore, 2013; Goldstein et al., 2017) that used a genetic algorithm to find optimal free parameter values to model this dataset. Within several iterations, the genetic algorithm routine converges on the parameters that yield the lowest error.



Example of photogrammetry data used to calibrate coastal dune model.

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MAY 2018

Findings/Benefits

This approach allows users to input actual topographic data into coastal dune models as an initial condition and to use observed initial topography, in combination with observed topography at a later time, to set free parameters. Beyond its utility in calibrating coastal dune models, the calibration workflow we developed is flexible, and can be used with other coastal morphodynamic models.

Status/Steps Moving Forward

We identified the need to continue to collect synchronous topographic and vegetation data in coastal dunes, and further test the ability of this calibration routine to help parameterize coastal models.

More Information

This work was funded through a USCRP Challenge Grant with additional leveraged funding from the NOAA Ecological Effects of Sea Level Rise Program. See also: Goldstein, E.B., and Moore, L.J., *in press.* A calibration workflow for coastal dune models. *Shore and Beach.*

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References

Durán Vinent, O. and Moore, L.J., 2013. Vegetation controls on the maximum size of coastal dunes. *Proceedings of the National Academy of Sciences*, v. 110, n.43, pp. 17217-17222, DOI:10.1073/pnas.1307580110.

Goldstein, E.B., Moore, L.J., and Durán Vinent, O., 2017. Vegetation controls on maximum coastal foredune 'hummockiness' and annealing time. *Earth Surface Dynamics*, 5, 417-427, DOI:10.5194/esurf-5-417-2017