TOOLS FOR SIMULATING AEOLIAN SEDIMENT TRANSPORT AND FOREDUNE EVOLUTION NEAR INLETS

INLET ENGINEERING TOOLBOX

NICHOLAS COHN, KATHERINE BRODIE

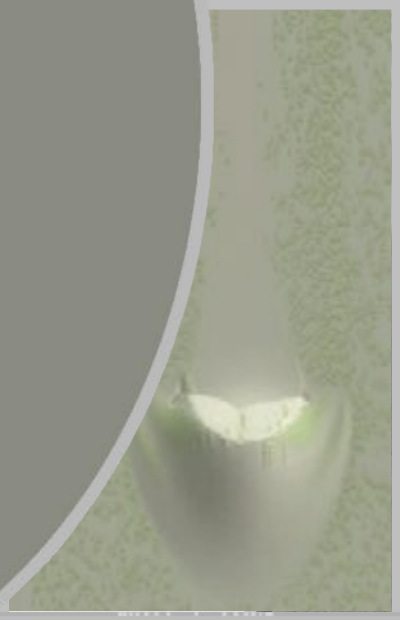
District PDT Members

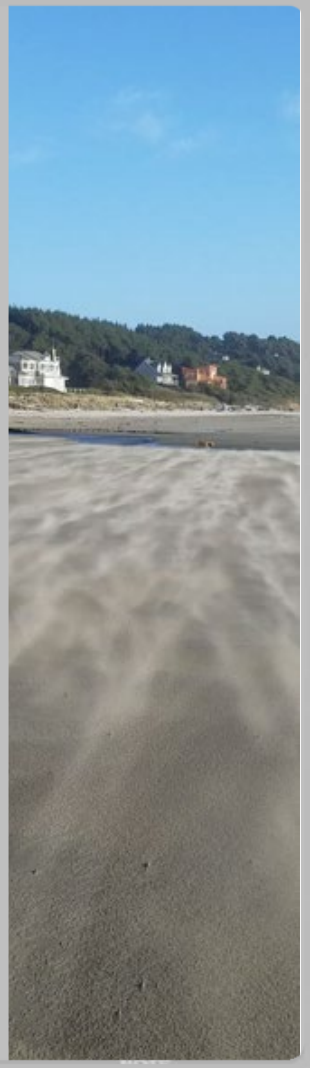
Rod Moritz , Jarod Norton (NWP)

Kevin Hodgens, Gabriel Todaro (SAJ)

Kathy Griffin
HQ Navigation Business Line Manager

Eddie Wiggins
Technical Director





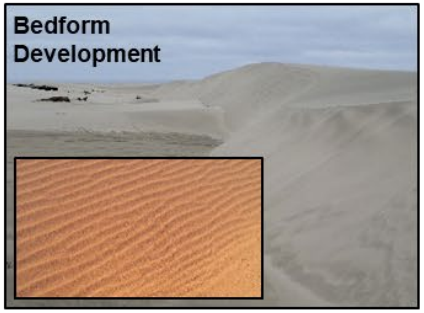
US Army Corps of Engineers®

CHL COASTAL & HYDRAULICS LABORATORY

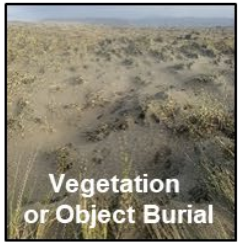
ERDC ENGINEER RESEARCH & DEVELOPMENT CENTER

DISCOVER | DEVELOP | DELIVER

BLUF



USACE currently has limited capabilities to predict wind-blown sediment transport processes and related morphological changes, including near complex inlet systems. This work aims to develop and extend state-of-the-art tools for simulating wind-driven sediment transport processes, including foredune evolution, in proximity to navigational channels and in other USACE-managed coastal settings.



FY19 research

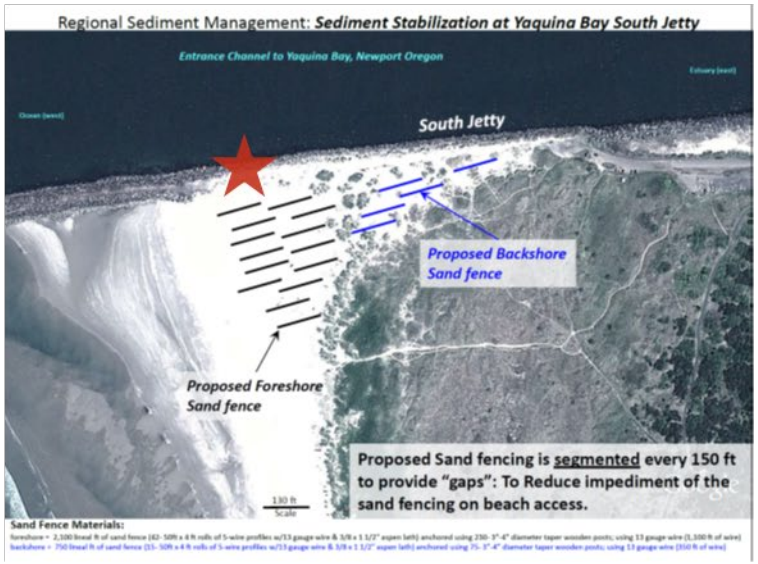
FY18 Tasks

- **Initial Development and Testing:** Dune Erosion Forecasting Tool (*DEFT*)

FY19 Tasks

- **Initial Development:** adapting *Aeolis* for coastal management needs
- **Validation and Webtool Development:** *DEFT*

FY19 research



Wind-blown sediment transport into inlets and waterways can cause navigation hazards which may require dredging at significant cost

Many management efforts to mitigate fluxes into coastal inlets are trial and error based.

FY19 research

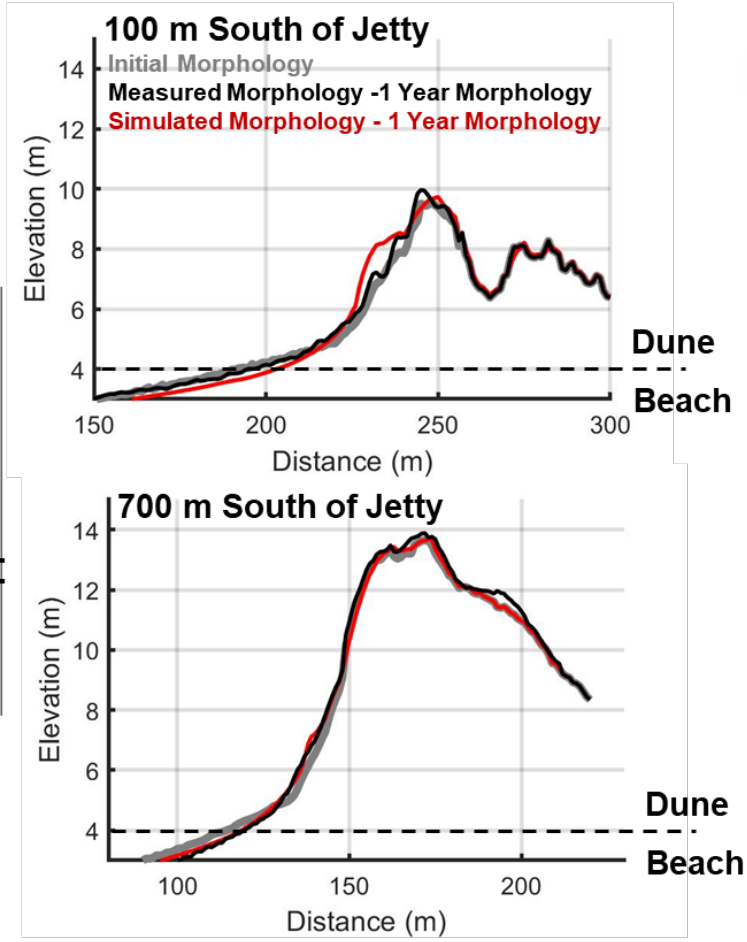
Aeolis (Hoonhout and de Vries, 2016)

- Open-source 2D aeolian sediment transport model that includes vertical sediment discretization
- Major advantage for coastal environments is that it accounts for winnowing and bed armoring effects

This project and ongoing academic collaborations aimed at extending model capabilities.

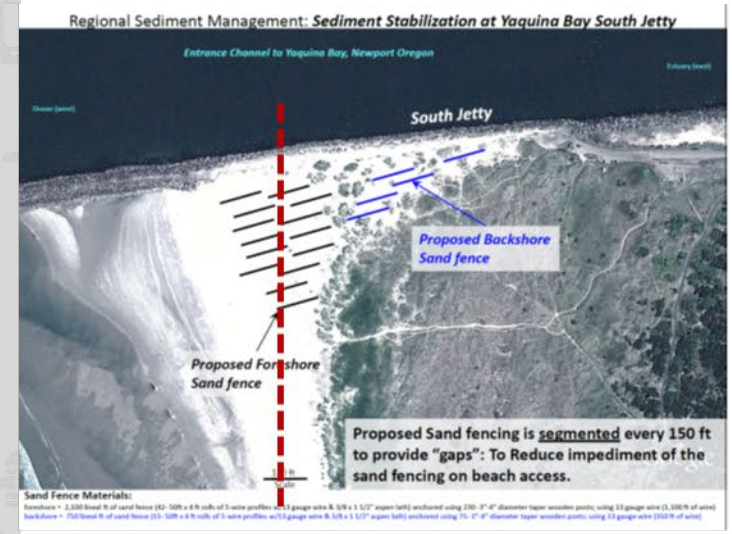
CDM Capabilities ported into Aeolis **Bart van Westen & Sierd de Vries** (Technical University of Delft)

Aeolis Application to SBSP



- Models qualitatively agree with field datasets of morphology change in the dunes
- No validation data available immediately at the inlet

FY19 research



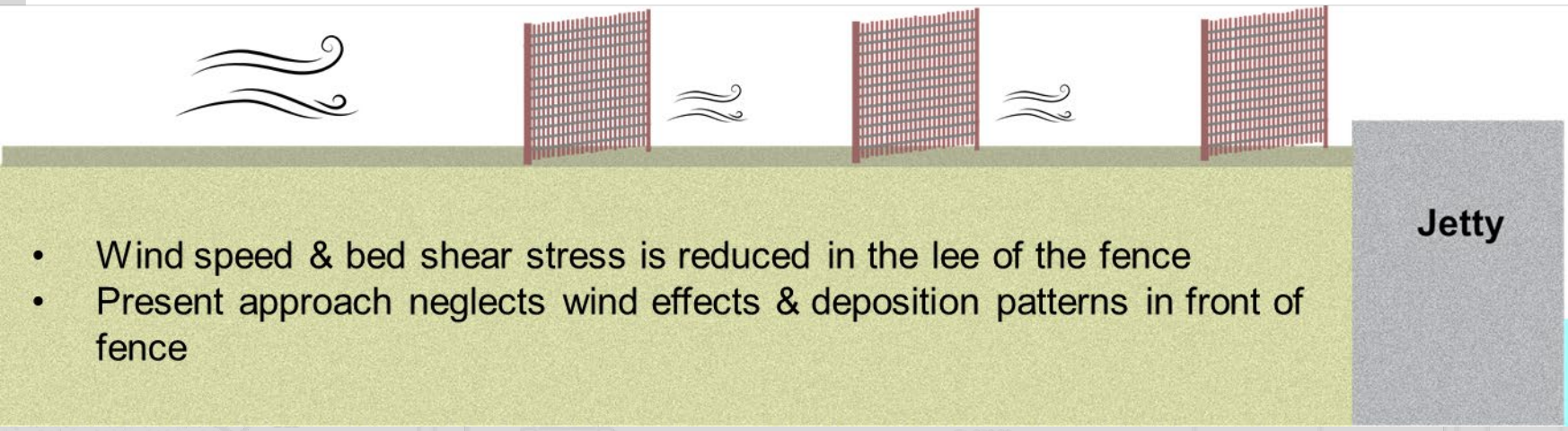
Wind Speed Reduction Factor

$$WSRF = 0.7 - 0.013\,\frac{x}{H}$$

Distance Behind Fence

Fence Height

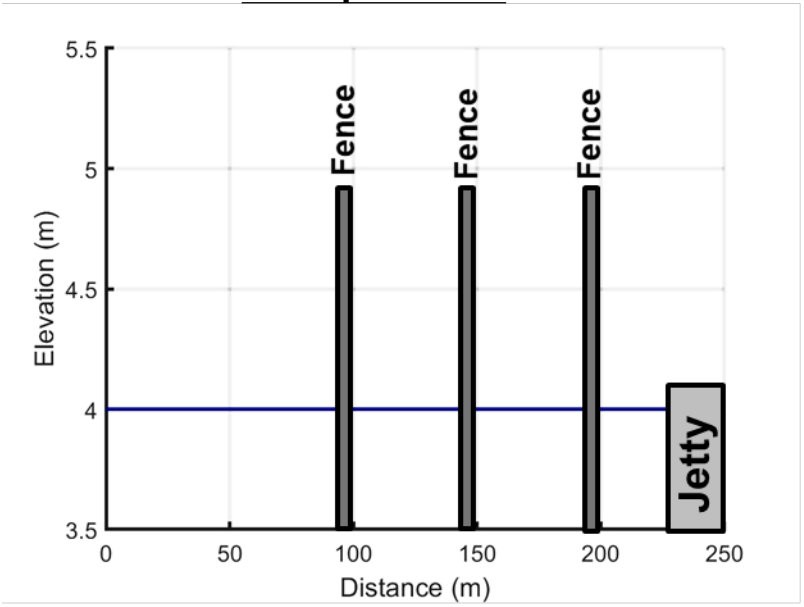
Simplified from work of Wilson (1987)



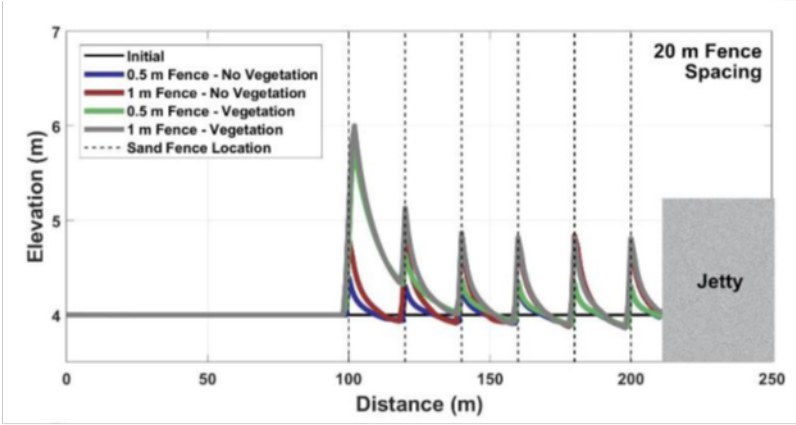
- Wind speed & bed shear stress is reduced in the lee of the fence
- Present approach neglects wind effects & deposition patterns in front of fence

FY19 research

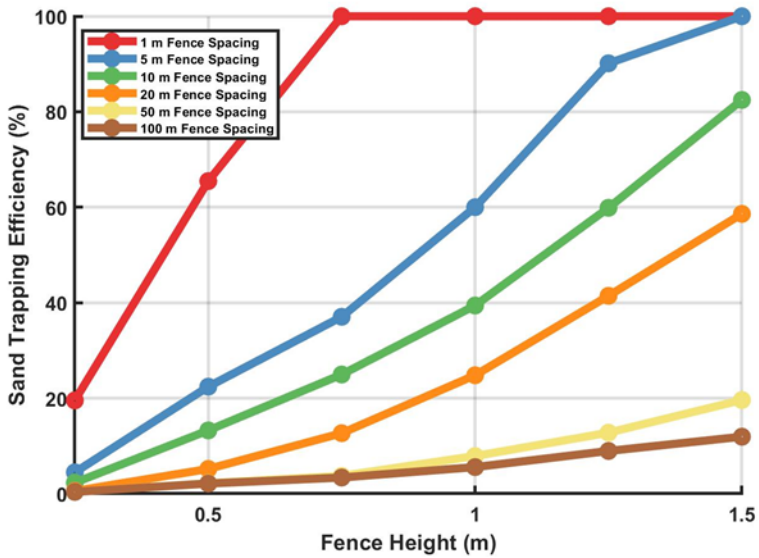
Example Video



Example Output: Fixed Fence Spacing



Example Output: Fence Height vs. Fence Spacing vs. Trapping Efficiency



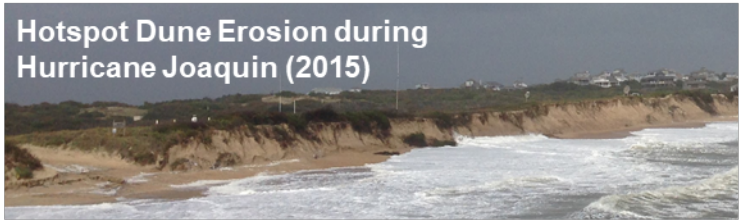
- Proof of concept simulations show potential applications for designing sand fence configurations and tradeoffs between fencing and vegetation

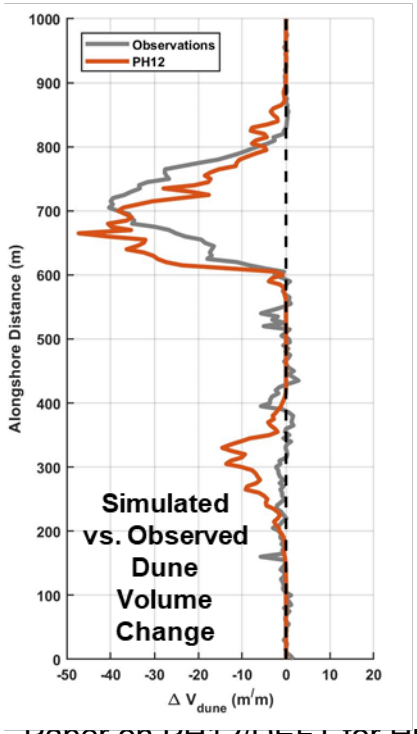
Cohn et al. (2019)
Coastal Sediments Proceedings

FY19 research

Dune Erosion Forecasting Tool (DEFT)

Model/Tool Application



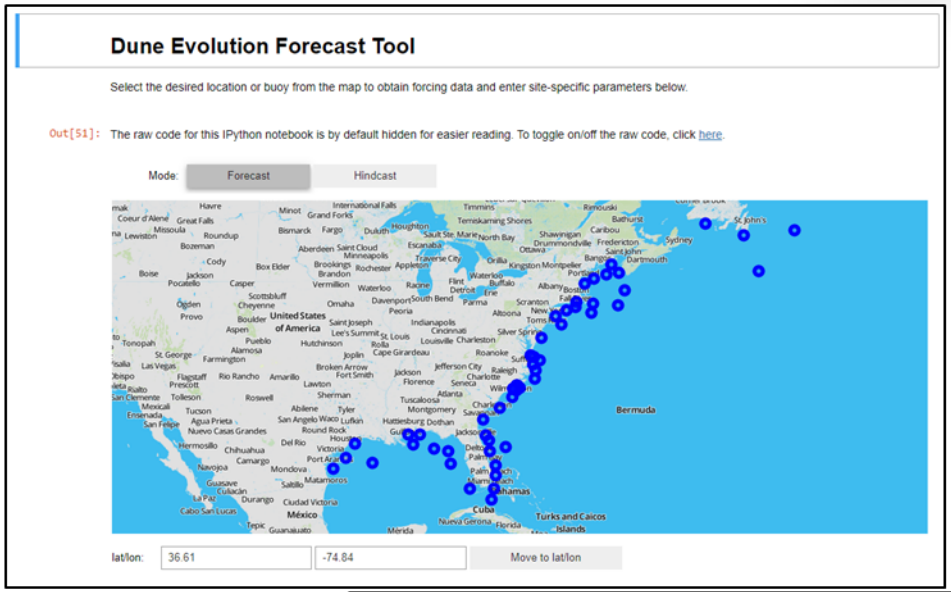


Model tested against dune erosion data at the FRF during Hurricane Joaquin.

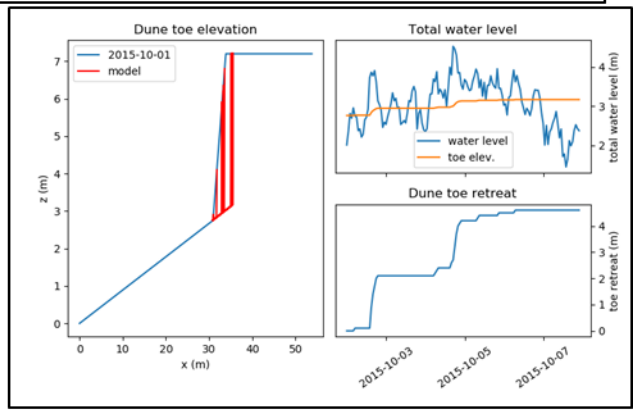
Captured alongshore characteristics of hotspot dune erosion, despite being a reduced complexity model

Paper on PH12/DEFT for Hurricane Joaquin to be submitted by end of FY

Webtool Development



→ Jupyter notebook deployed on server
→ Can run in forecast (NOAA ESTOFS & WW3) or hindcast (WIS or NOAA bouys) mode



Summary

FY19: Advancements

- Initiated adaptation of an open-source aeolian transport model (*Aeolis*) for inlet and coastal-relevant management needs
- Developed capabilities to account for sand fencing and vegetation for trapping sediment in 1D. Proof of concept completed.
- GUI development for *DEFT*

FY20: Next Steps

- Expand *Aeolis* coastal management capabilities to 2D and validate against available data from the Pacific Northwest
- Initiate coupling of Aeolis with *C2Shore*
- Complete rollout of *DEFT* to Districts for testing