The effect of nourishments on dune erosion during a storm sequence:

Modelling dune erosion with XBeach at the partly nourished Egmond coast

Bart van der Waal[1], Merijn Niemeijer[1], Anne de Beer[2], Bart Grasmeijer[1,2], Laura Brakenhoff[3], Timothy Price[1]

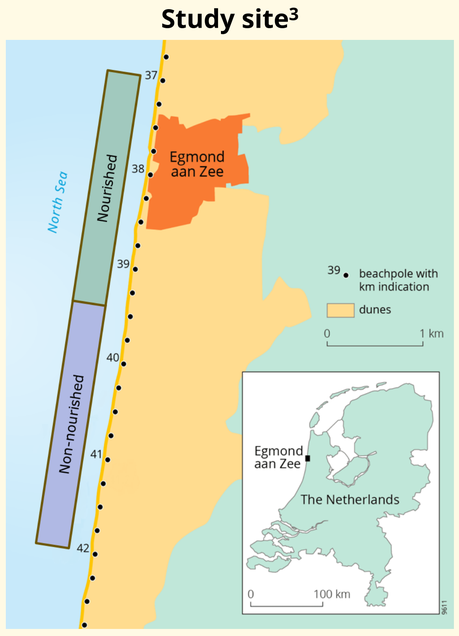
[1]Utrecht University (j.b.vanderwaal@students.uu.nl), [2]Deltares, [3]Rijkswaterstaat

Motivation

- The Dutch coast is one of the most heavily nourished coasts in the world[1]
- Long-term effect of nourishments remains unclear[1]
- Nourishment may act as a direct buffer against dune erosion during a storm
- Sequences of storms may lead to different responses of the beach-dune system for a non-nourished coast[2]

Dune erosion at Egmond aan Zee

Study site[3]



Objectives

Provide insight into the effect of nourishments on dune erosion during a storm sequence by investigating:

1. The difference in dune erosion between a nourished and non-nourished stretch of coast during a storm sequence
2. The effect of different nourishment designs on dune erosion during a storm sequence

Approach

Numerical model XBeach (BOI-version)

Hydrodynamics

- Storm sequence Corrie, Dudley, Eunice and Franklin in winter 2021/2022

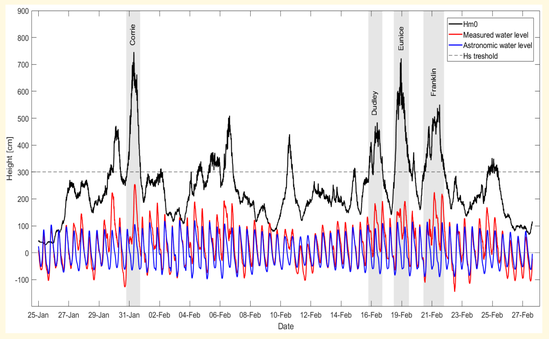
Bathymetries

- 6 bathymetries Egmond aan Zee 2020-2023 → nourished and non-nourished site (divided by beach pole 39.5)
- Bathymetry October 2023 + nourishment designs
- Bathymetry March 2021 without outer subtidal bar (maintained by nourishments)

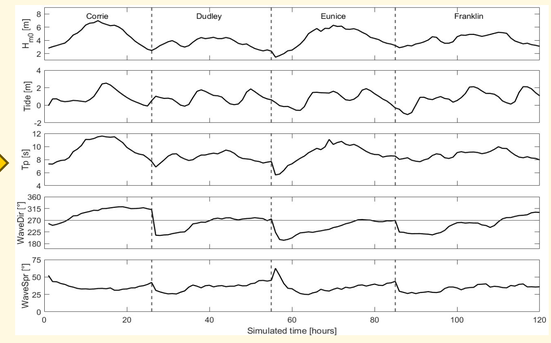
Bathymetries Egmond

Nourishment designs

Offshore wave data

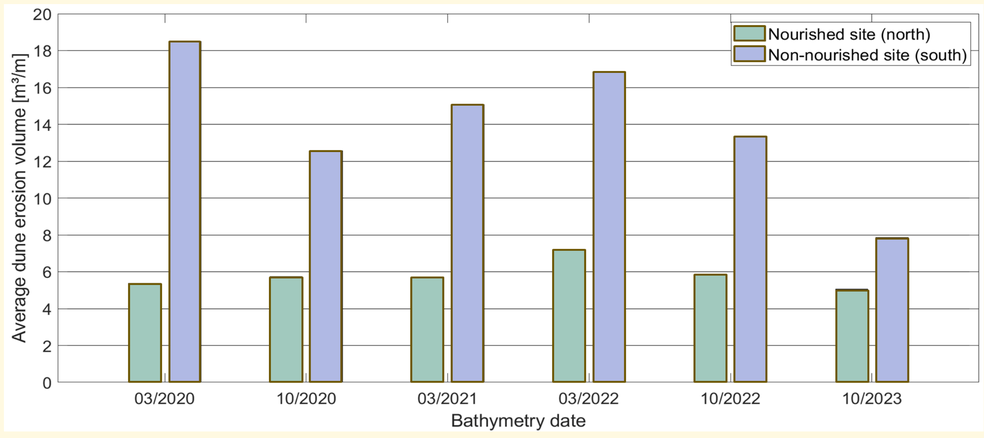


Simulated storm sequence

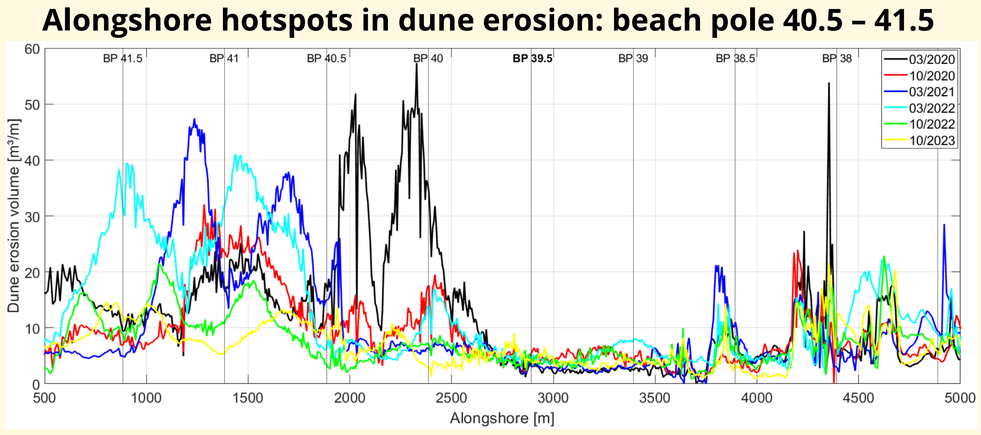


Morphodynamics

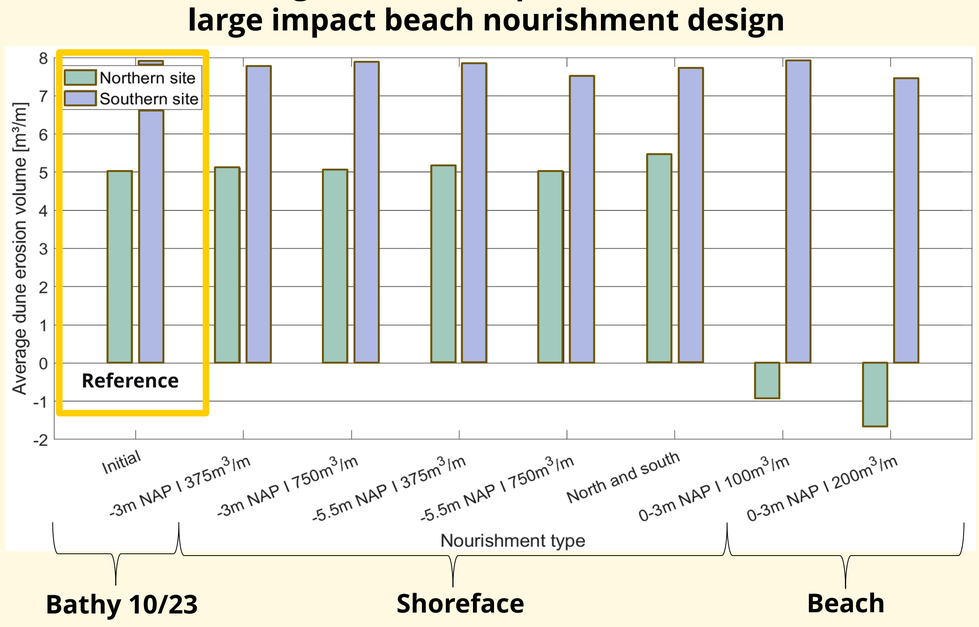
Dune erosion: consistent decrease in nourished site



Alongshore hotspots in dune erosion: beach pole 40.5 – 41.5

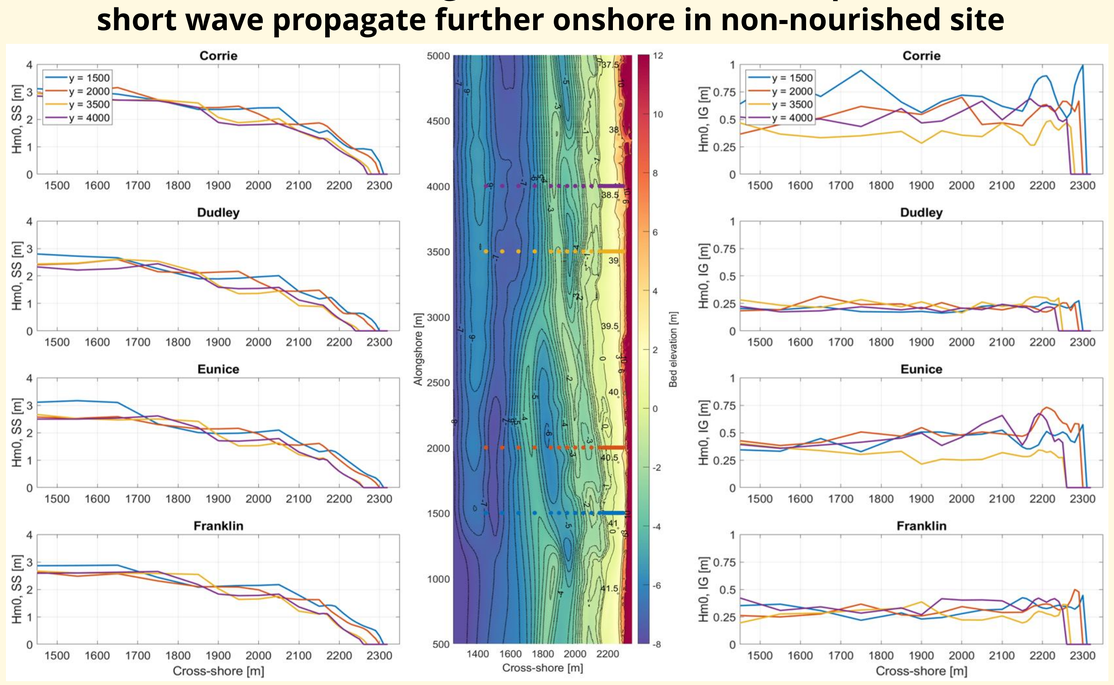


Nourishment designs: limited impact shoreface nourishment, large impact beach nourishment design

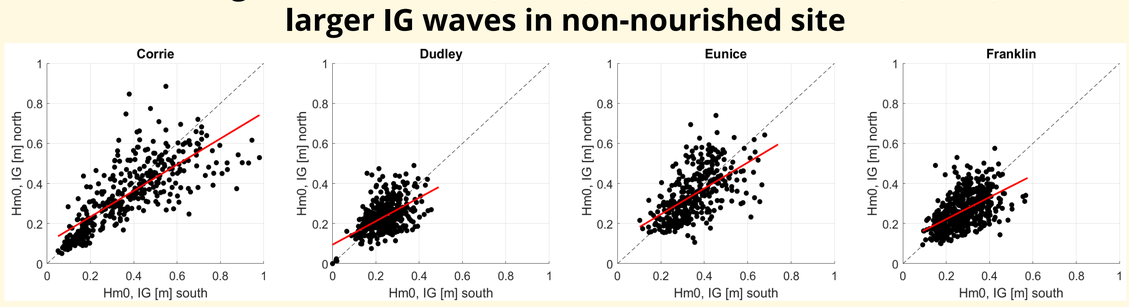


Hydrodynamics

Short and IG wave height cross-shore evolution per storm: short wave propagate further onshore in non-nourished site



IG wave height in nourished (north) and non-nourished (south) site: larger IG waves in non-nourished site



Conclusions

Repeated nourishment decreases dune erosion rates

- Increased wave dissipation over the shallower and further onshore positioned subtidal bars in the nourished site
- A persistent erosional hotspot in the non-nourished site corresponds to the alongshore location of a deeper area in the nearshore bathymetry

Shoreface nourishment presence barely reduces dune erosion volume

- Suggesting that shoreface nourishment effects on dune erosion develop over timescales longer than that of a single storm season

Beach nourishment presence significantly reduces dune erosion volume

- Since the entire beach and height of the dune toe are raised

Referenties

1. Brand, E., Ramaekers, G. & Lodder, Q. (2022). Dutch experience with sand nourishments for dynamic coastline conservation–an operational overview. Ocean & Coastal Management, 217 , 106008. doi: https://doi.org/10.1016/j.ocecoaman.2021.106008
2. Eichentopf, S., Karunarathna, H. & Alsina, J. M. (2019).Morphodynamics of sandy beaches under the influence of storm sequences: Current research status and future needs. Water Science and Engineering, 12 (3), 221-234. doi: https://doi.org/10.1016/j.wse.2019.09.007
3. de Winter, R., Gongriep, F. & Ruessink, B. (2015). Observations and modeling of alongshore variability in dune erosion at egmond aan zee, the netherlands. Coastal Engineering, 99 , 167-175. doi: https://doi.org/10.1016/j.coastaleng.2015.02.005