Spatio-temporal aeolian sand dispersal patterns in a coastal dune system, the Kennemerduinen (the Netherlands)

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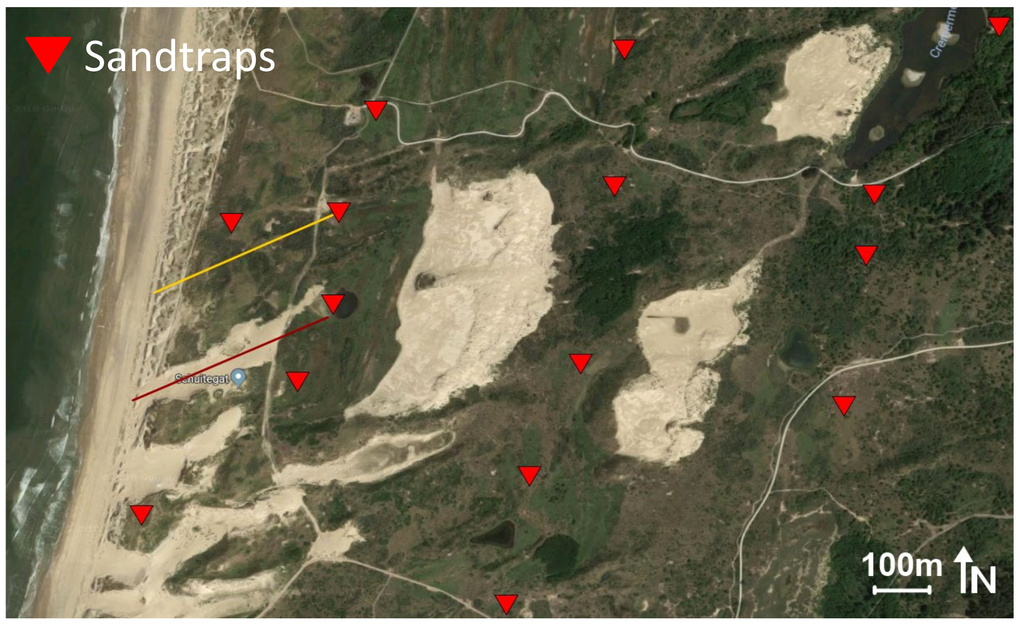
Introduction

Dune revival project - In the National Park Zuid Kennemerland, near the town of IJmuiden, notches have been dug in the foredune ridge and vegetation is removed from inland dunes to reactivate and promote aeolian transport of $CaCO_3$-rich beach sand towards the dune system. This project is executed to increase coastal safety and protect the coastal dune biodiversity.

Monitoring sediment dynamics [1] - Since the start of this project (2013-present) sand transported in *suspension* has been trapped and collected every two weeks in sandtraps (n=15) custom made by Arens Bureau for Beach and Dune Research.

Objectives - Here we investigate the spatial and temporal aeolian sediment dispersal patterns during one of those years (2017).



Dominant modes of sediment transport:

Saltation
Upper beach and bare notches

Modified saltation
Initial vegetation in foredune

Suspension
Fully vegetated dune area

Methodology

Suspended sand collected in 15 sediment traps:
2-weeks resolution from 2013-2019

Flux data:
2013-2019, N=1950
2017, N=344

Dynamic image analysis:
grain size and shape distributions
2017, N=207

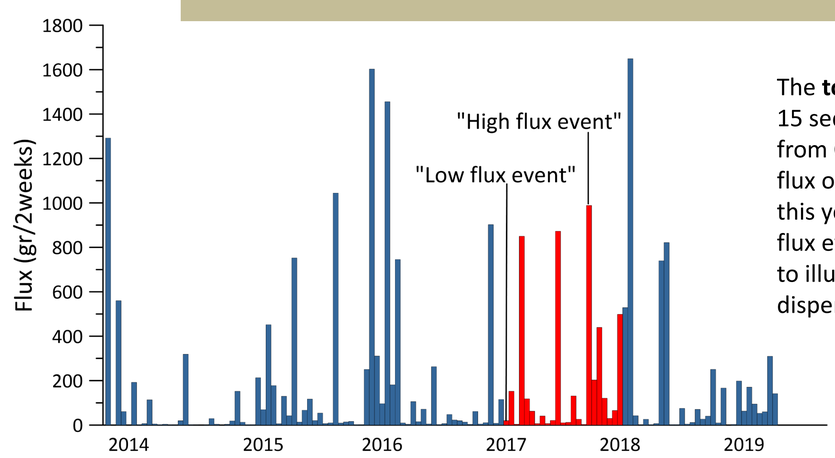
Thermo gravimetric analysis:
carbonate content
2017, N= 128

Conclusions

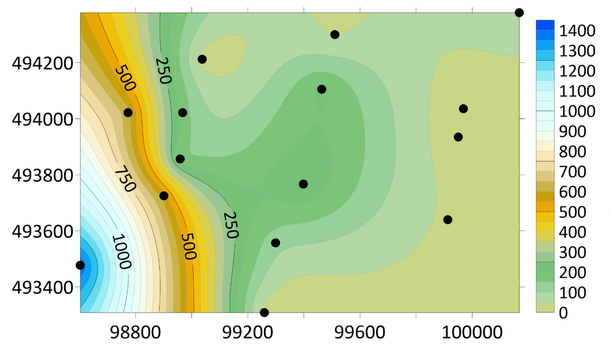
- The suspended sand fluxes recorded in the sand traps shows high temporal variability and systematic spatial down-wind decreasing trends.
- The size-shape distributions show the existence of two subpopulations:
  - a coarse population transported by modified saltation
  - a fine population transported in suspension
- The contribution of the modified saltation subpopulation decreases and the suspension subpopulation increases along the foredune ridge – inner dune transect reflecting systematic down-wind sorting trends of grain size and grain shape.
- The suspended sand subpopulation is enriched in carbonate indicating that the dune revival project resulted in increased input of carbonate-rich beach sand towards the dune system.

References
[1] Arens, S.M., Neijmeijer, T., Tongeren, O., 2015. Noordwestkern Effecten van ingrepen op dynamiek Resultaten monitoring 2013-2015
[2] Van Hateren, J.A., van Buuren, U., Arens, S.M., van Balen, R.T., Prins, M.A., 2020. Identifying sediment transport mechanisms from grain size-shape distributions. Earth Surface Dynamics, 8, 527–553.

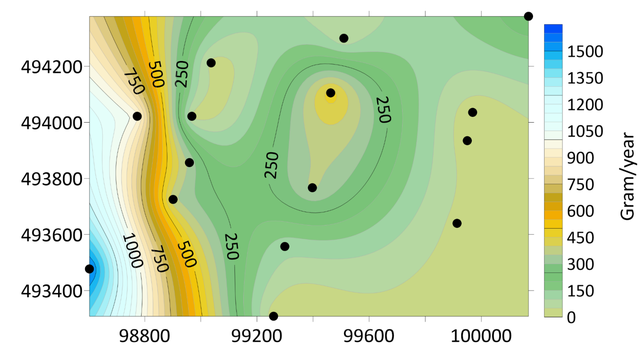
Sediment flux



The **total sediment flux** collected in the 15 sediment traps in 2-week periods from October 2013 to April 2019. The flux of 2017 is indicated in red: within this year a “high flux event” and a “low flux event” is highlighted which is used to illustrate spatio- and temporal dispersal patterns.

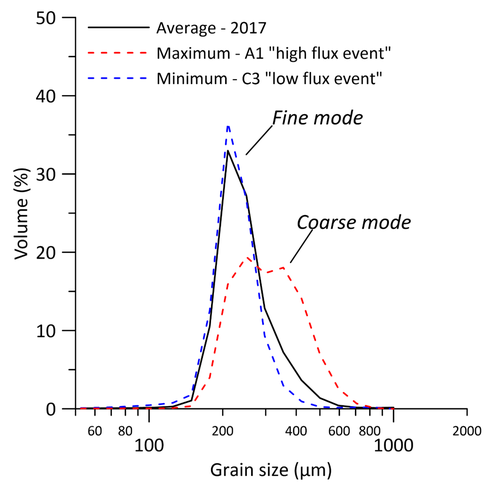


The **average annual flux (gr/yr) in 2013-2019** shows a decrease in transported sediment from the foredune ridge towards the inner dune system. The additional contribution of the bare parabolic dune is clearly visible in traps C3 and C4.

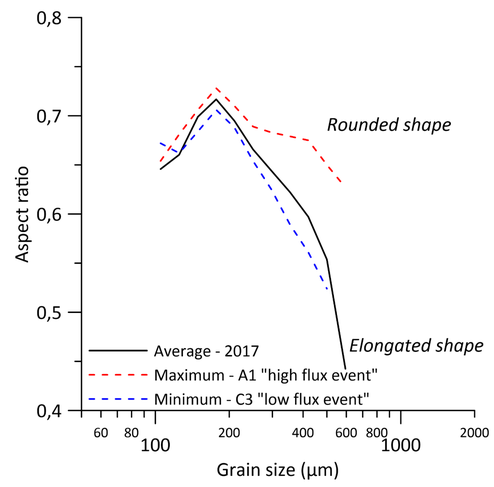


The **annual flux (gr/yr) in 2017** shows a similar spatial pattern as in 2013-2019 reflecting a systematic down-wind decreasing flux pattern from the source (beach) to the sink (dunes).

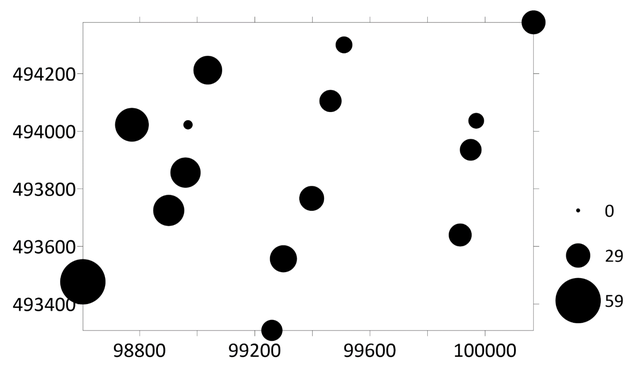
Grain size and shape



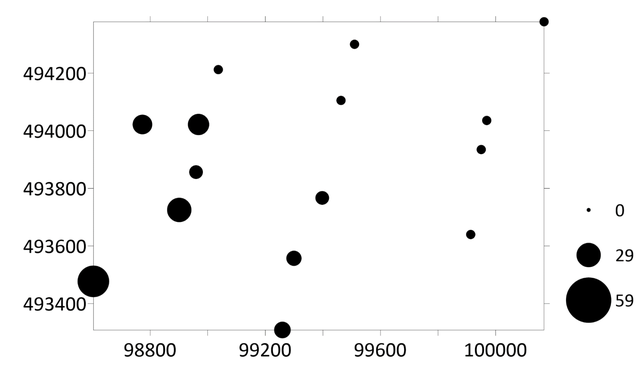
The average, ‘minimum’ and ‘maximum’ **grain size distributions of 2017**. The distributions show two populations with a fine mode of 210 µm and a coarse mode of 400 µm. The “high flux event” shows the highest contribution of the coarse mode. The boundary between the two modes is around 250 µm.



The average, ‘minimum’ and ‘maximum’ **grain shape (aspect ratio, AR) distributions of 2017**. The AR decreases with increasing grain size, illustrating more elongated particles with increased grain size. The “high flux event” shows the highest AR values (rounded particles = modified saltation [2]), the “low flux event” the lowest AR values (elongated particles = suspension [2]).

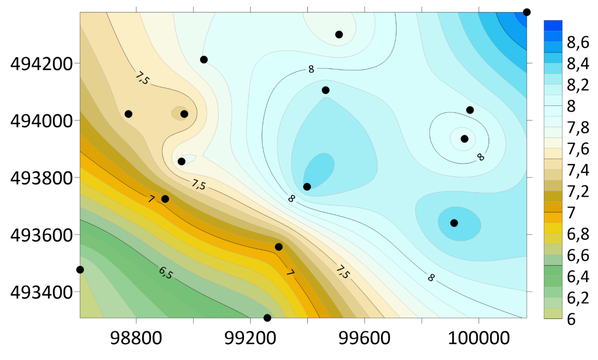


The **coarse fraction (>250 µm)** of the “high flux event” decreases towards the inner dunes, reflecting a systematic size sorting patterns.

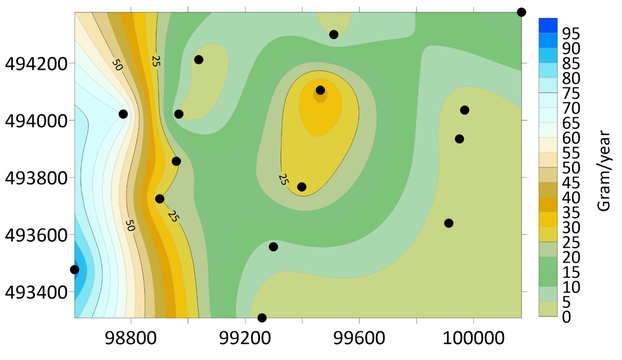


The coarse fraction (>250 µm) of the “low flux event” shows lower volumes but with a similar down-wind decreasing trend.

Carbonate content



The average **carbonate content (wt%) in 2017** shows a subtle but systematic down-wind increase from the foredune ridge towards the inner dunes.



The **annual carbonate flux (gr/yr) in 2017** shows a strong down-wind decrease.