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Video monitoring of aeolian activity on a narrow beach

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Introduction

Dunes need sediment to grow and recover from storms. This sediment comes from the beach and is transported towards the dunes by the wind. High aeolian transport rates are expected for high wind velocities, but this is not always the case for narrow beaches (width of tens of meters). In other words, weather conditions that seem favourable for aeolian transport do not always result in actual transport. What limits aeolian transport rate is not well understood.

Main questions:

- Which conditions create aeolian transport towards the dunes?
- Which factors limit aeolian sediment transport?

Used Data

- Argus Images from the Coast3D tower at Egmond aan Zee.
- KNMI weather data from de Kooy.
- 8 years of data (2005 – 2012)

Methodology

- Data from the KNMI were used to find moments with potential sediment transport (wind events).
- Wind events were classified on according to their potential transport rate (see table 1), calculated with:

$$Q = 1.16 * 10^{-5} * u^3 * 3600$$

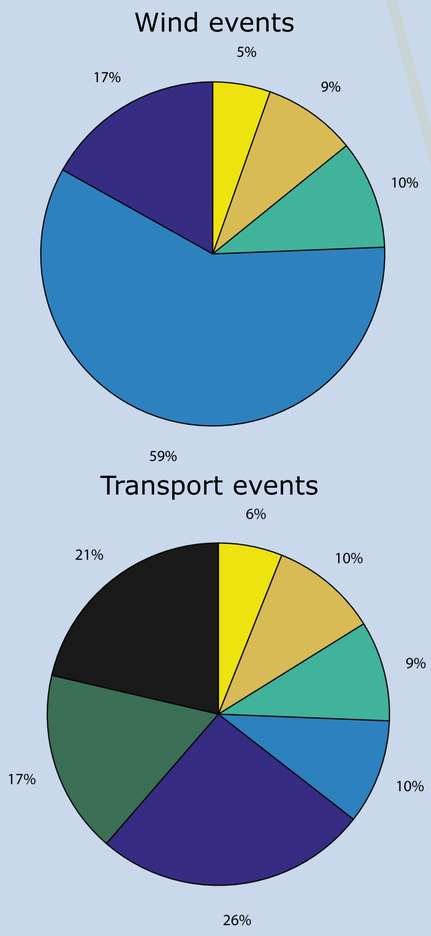
Where u is the wind velocity (Hsu, 1974).

- The Argus images were visually classified, based on aeolian activity in the form of sand strips and streamers (transport events, see figure 1).
- The classes of the wind and transport events (figure 2) were compared to each other. Transport is limited when it's prediction was high, but low in reality (high wind class, low transport class).

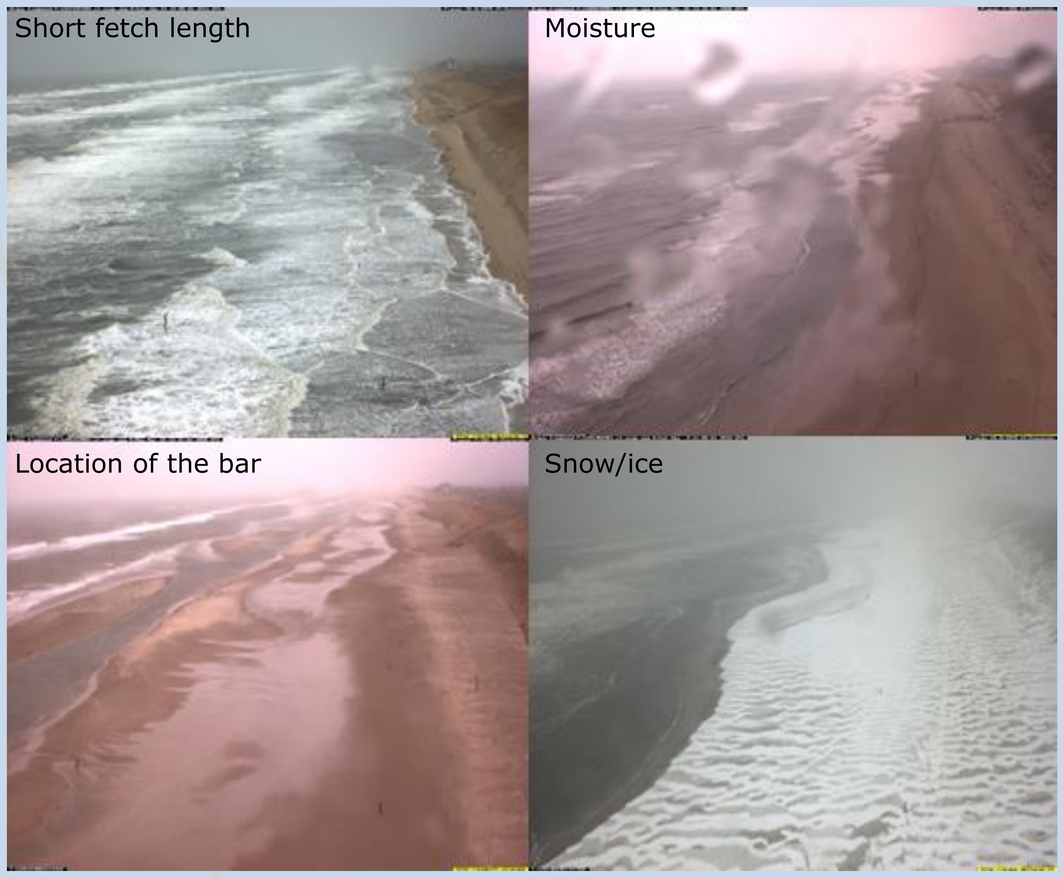
Wind class	Potential aeolian transport rate (kg/m/hour)
1	very small: < 30
2	small: 30 – 60
3	medium: 60 – 90
4	large: 90-120
5	very large: > 120

Table 1: Wind event classes based on potential transport rates.

Figure 1: Transport event classes based on visual inspection.



← Figure 2: Percentage of classes for wind and transport event.



↑ Figure 3: Examples of limited transport.

References
Hsu, S.A. (1974). Computing aeolian sand transport from routine weather data, Proc. 14th Coastal Engineering Conf., ASCE, New York, pages 1619–1626

Results

- A long fetch, a strong wind and an onshore wind direction are generally assumed to lead to optimal dune growth (high wind class). These conditions lead to no or minimal sand transport on Egmond beach (low transport class).
- Instead, alongshore winds result in substantial aeolian activity, but it is unknown how much this wind-blown sand actually ends up in the dune.
- Also, transport often happens only during low tide, because the beach becomes too narrow during high tide.
- Short fetch is thus the most important limiting factor.
- Other limiting factors are moisture, the location of the intertidal bar and snow (see figure 3 and table 2).

Limiting factor	Fetch	Moisture	Bar location	Snow/ice
Number of events	177	103	38	15
Percentage of all events (%)	18,44	10,73	3,96	1,56
Percentage of limited events (%)	68,87	40,08	14,79	5,84

Table 2: Occurrence of limiting factors. There are 960 events in total.

Conclusions

Both strong and weaker winds can cover the beach with sand strips, as long as the wind direction is alongshore. Strong winds with a predominantly onshore direction do not result in transport and might lead to dune erosion instead. Four major transport limiting factors were found: short fetch, moisture, the location of the bar, and snow and/or ice.