Aeolus meets Poseidon

a Vici project on wind-blown sand transport on wave-dominated beaches

Introduction

Coastal dunes serve as a natural safety barrier against marine flooding and possess high ecological value with many environmental transitions (wet/dry, salt/fresh). The societal need for safe coasts has resulted in over-stabilized dunes that can withstand the impact of fierce storm waves, but have impoverished natural values and undesirably reduced biodiversity. We now face the challenge of combining coastal safety objectives with nature development to maintain sustainable and climate-proof dunes. This demands profound quantitative understanding of aeolian (wind-blown) processes, rather than of storm-wave processes alone. Wind-blown beach sand allows dunes to grow vertically with sea-level rise, thereby ensuring long-term coastal safety, and is crucial to sustain the dunes’ biodiversity by resetting ecological succession locally and temporally.

The overarching aim is to develop a robust, efficient and accurate predictive model, applicable in both scientific and applied studies, of meso-scale (several years) aeolian sand supply to dunes. The focus is on natural, long (>1 km) dunes that can withstand the impact of fierce storm waves, but have impoverished natural values and undesirably reduced biodiversity. We now face the challenge of combining coastal safety objectives with nature development to maintain sustainable and climate-proof dunes. This demands profound quantitative understanding of aeolian (wind-blown) processes, rather than of storm-wave processes alone. Wind-blown beach sand allows dunes to grow vertically with sea-level rise, thereby ensuring long-term coastal safety, and is crucial to sustain the dunes’ biodiversity by resetting ecological succession locally and temporally.

Research projects

Aeolian transport on beaches is influenced strongly by the moisture of the top few millimetres of sand. Moisture and sand transport interact to create fascinating aeolian bedforms that, in turn, lead to reduced biodiversity. We now face the challenge of combining coastal safety objectives with nature development to maintain sustainable and climate-proof dunes. This demands profound quantitative understanding of aeolian (wind-blown) processes, rather than of storm-wave processes alone. Wind-blown beach sand allows dunes to grow vertically with sea-level rise, thereby ensuring long-term coastal safety, and is crucial to sustain the dunes’ biodiversity by resetting ecological succession locally and temporally.

Moisture dynamics (PhD 1)

Aims
- to identify temporal and spatial dynamics in surface moisture
- to elucidate their key controls
- to develop a realistic model to predict these dynamics.

Approach
- field measurements of surface moisture using infrared terrestrial laser scanning, extended with measurements of phreatic groundwater levels, vertical moisture profiles, and precipitation and various atmospheric parameters
- numerical modelling of beach hydrology

Moisture-transport feedback (PhD 2)

Aims
- to characterize the frequency, timing and relative magnitude of aeolian transport events
- to understand better which key parameters control meso-scale sand supply from narrow beaches.

Approach
- 15-year long Argus data set. Moisture-transport feedback is visible as beautiful aeolian bedforms, known as sand strips,
- modelling of sand-strip dynamics through a cellular automation model.

Transport magnitude (PhD 3)

Aim
- to improve predictions of the aeolian transport rate, including its variation in downwind direction from the location of no transport to the beach-dune transition.

Approach
- field measurements using spatially extensive network of high-frequency saltation sensors, extended with sonic anemometers, sand catchers, a high-speed video camera and a terrestrial laser scanner.

Meso-scale modelling (postdoc)

Aims
- to develop the meso-scale sand supply model,
- to quantify uncertainties inherent to the model predictions.

Approach
- translate detailed results of PhD projects 1-3 into parameterizations inherent to the critical fetch model of Bauer and Davidson-Arnott (2002),
- Monte-Carlo simulations.

Stakeholders:

PWV, Hoogheemraadschap Hollands Noorderkwartier, ARCADIS, Vereniging Natuurmonumenten, Witteveen+Bos, Royal Boskalis Westminster N.V., Arens Bureau voor Strand- en Duinonderzoek, Deltares, Rijkswaterstaat (Water, Verkeer en Leefomgeving

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