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Modelling airflow patterns in a man-made trough blowout

Jasper Donker (1), Erik van Onselen (1,2), and Gerben Ruessink (1)

(1) Department of Physical Geography, Utrecht University, The Netherlands, (2) Hoogheemraadschap van Rijnland, The Netherlands

Natural coastal foredune systems often contain blowouts, through which beach sand is blown into the more landward dunes. Along many developed coasts, blowouts have long been considered a safety hazard, endangering the strength of the foredune as the primary sea defense. Natural blowouts have thus been actively vegetated to promote sand accumulation in the foredune. Recent studies have, however, illustrated that the cessation of sand input in the landward dunes has contributed to a reduction in biodiversity. Nowadays, the safety of coastal foredunes can be assessed with sufficient accuracy allowing for the reintroduction of blowouts. As there is little knowledge on how to optimize blowout layout, the present approach is largely ‘learning by doing’. As a result, many different layouts, varying in blowout width, plan view and orientation, have been adopted in various dune restoration projects. The aim of this study is to model the airflow through an existing man-made blowout and to validate the model results using field observations. We expect that a better understanding of airflow patterns will help in optimizing the design of future blowouts as part of dune restoration projects.

The open source Computational Fluid Dynamics (CFD) package OpenFOAM was used to model wind flow through a man-made trough blowout in Dutch National Park Zuid-Kennemerland. The length of the blowout extends roughly 100 m through the foredune; its width narrows from 100 m at the seaward entrance to 20 m at its narrowest part after which it widens again. The deepest part is around 7 m above mean sea level (MSL) while the crest of the surrounding foredune is at 21 m above MSL. The blowout orientation is nearly parallel to the dominant SW wind direction and oblique with respect to the approximately N-S coast line. The field data comprises long-term (many months) observations of wind speed and direction at four locations on the blowout basin and depositional lobe. The model is able to reproduce the observed topographical steering of the wind towards the blowout normal under oblique wind approach as well as the wind-speed acceleration toward the narrowest part of the blowout. Consistent with the observations, the degree of steering and acceleration depend strongly on the wind approach angle, not on the wind speed. As a next step we envision the modeling of different blowout topographies to determine the blowout shape that potentially maximizes the sand transport toward the landward dunes.