Universiteit Utrecht

Faculty of Geosciences
Physical Geography

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Observations of Beach-Dune Interaction in Man-Made Trough Blowouts

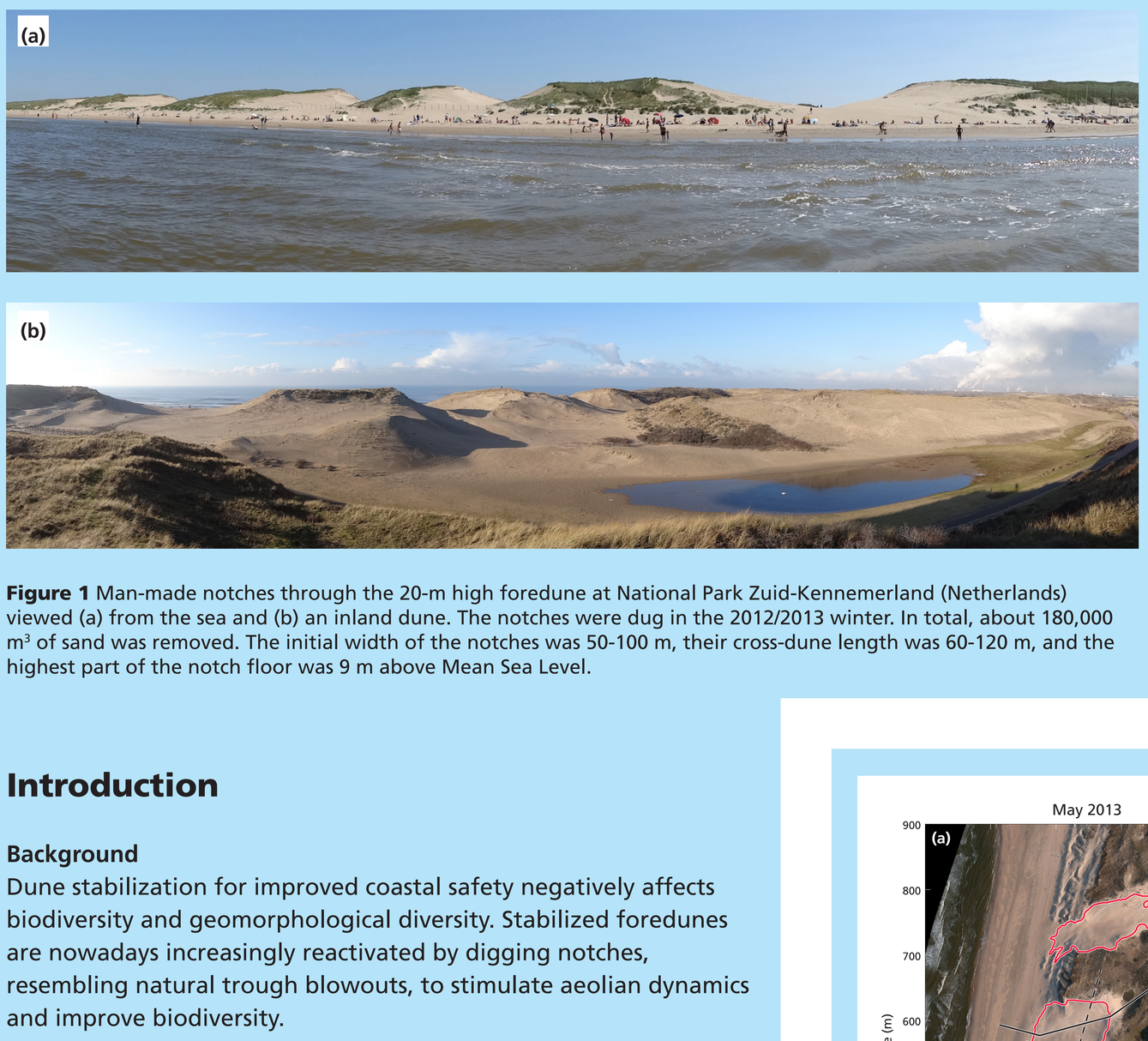

Figure 1 Man-made notches through the 20-m high foredune at National Park Zuid-Kennemerland (Netherlands) viewed (a) from the sea and (b) an inland dune. The notches were dug in the 2012/2013 winter. In total, about 180,000 m³ of sand was removed. The initial width of the notches was 50-100 m, their cross-dune length was 60-120 m, and the highest part of the notch floor was 9 m above Mean Sea Level.

Introduction

Background
Dune stabilization for improved coastal safety negatively affects biodiversity and geomorphological diversity. Stabilized foredunes are nowadays increasingly reactivated by digging notches, resembling natural trough blowouts, to stimulate aeolian dynamics and improve biodiversity.

Problem definition
Learning-by-doing: the evolution of man-made notches and their long-term (> years) effectiveness are not understood.

Aim
To analyse the evolution of five notches dug through the 20-m high foredune at the Dutch National Park Zuid-Kennemerland (Figure 1).

Methodology

Digital Elevation Models (DEMs) with a 1x1 m resolution were obtained using:

- Airborne laser scanning (ALS): 1 pre-survey (February 2012) and 4 post-surveys (February 2013-March 2015).
- UAV photography: 5 post-surveys (May 2013-April 2015). The typically 500-1000 aerial photographs obtained during a flight were processed using the Structure-from-Motion workflow in AgiSoft Professional. The resulting 3D point cloud was georeferenced using 40 ground control points with known coordinates and then processed into a DEM. While ALS can detect the terrain surface beneath vegetation, UAV DEMs contain the top of the vegetation. Here, vegetation was detected using the ExG-ExR methodology (Meyer and Neto, 2008; Computers and Electronics in Agriculture) from the UAV orthophotos and replaced by elevation data from the nearest (in time) ALS survey.

Main findings

UAV-derived orthophotos (Figures 2a and b) and elevation difference data (Figure 2c) illustrate unprecedented wind-induced geomorphological changes.

- (Figures 2c and 3) Notch cross-section has become more U-shape because of sidewall erosion. Notch width and depth have remained largely unaltered.
- (Figures 2 and 4) Large depositional lobes have developed landward of the notches, locally exceeding 7 m in thickness and 50 m in length. Additionally, some sand has been deposited on the foredune between the notches.
- (Figure 2c) In total, some 24,000 m³ of sand was eroded from the five notches after 2 years, while about 44,000 m³ of sand was deposited further landward. This suggest that 20,000 m³ of beach sand was blown through the notches, corresponding to roughly 12.5 m³/m/year.

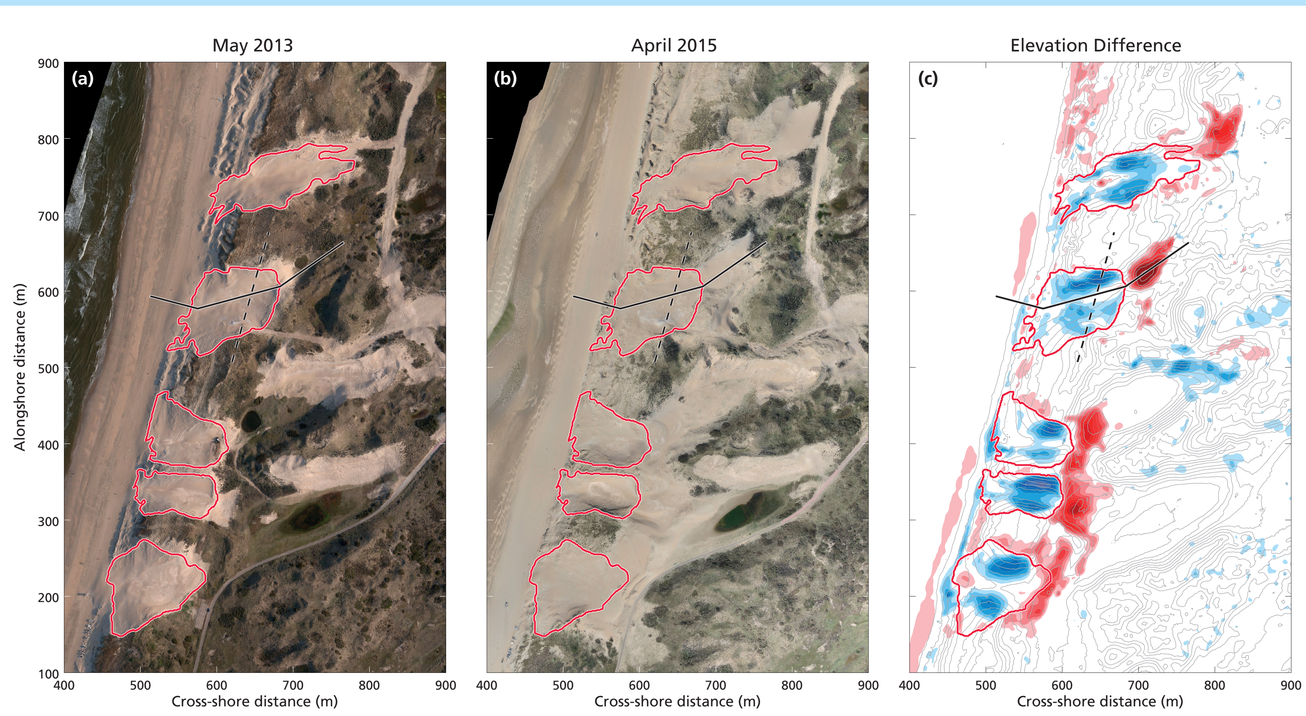

Figure 2 Orthophoto of the study area (a) immediately after notch construction (May 2013) and (b) 2 years later (April 2015). Panel (c) shows the elevation difference two years after notch construction, with deposition in red and erosion in blue. The colors range from -5 to +5 m; absolute differences less than 0.5 m are shown in white. The grey lines are the May 2013 elevation contours from 0 to 20 m above Mean Sea Level with a 2-m step size. In all panels, the red lines outline the five notches. The elevations along the black dashed and solid lines are shown in Figures 3 and 4, respectively.

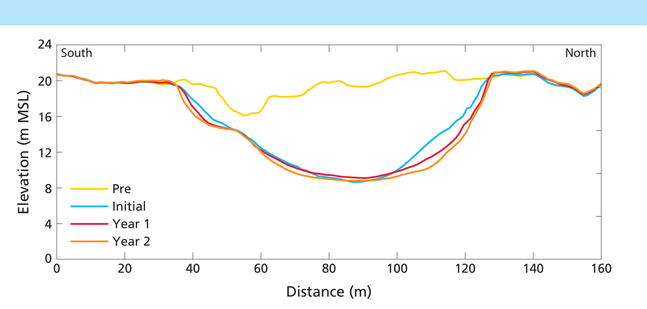

Figure 3 Elevation with respect to Mean Sea Level versus distance across one of the notches (dashed line in Figure 2) for various moments in time.

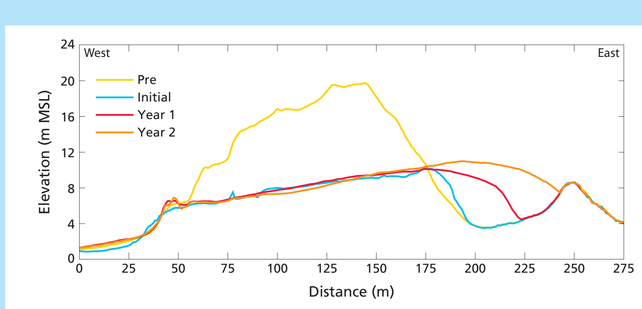

Figure 4 Elevation with respect to Mean Sea Level versus distance through one of the notches (solid line in Figure 2) for various moments in time.

Acknowledgements

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