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## The influence of dune pavilions on longer term dune development

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### 1. INTRODUCTION

The European beach-dune systems are under increasing pressure due to urbanization, beach tourism and the effects of climate change like rising sea level and increased storm intensity. Building with nature solutions (Stive *et al.*, 2013) are advocated as an effective and adaptable approach to protect sandy coasts in the future. This approach however interacts with the increased human use of the beaches- which can have an adverse impact on the efficiency of the building with nature approach. Especially permanent structures influence the natural sand transport dynamics from the beach to the dunes and can have long lasting effects on dune development.

To obtain more insight into the influence of buildings on longer term dune development a 3-months 'Scanex 2020' field campaign was conducted (Poppema *et al.*, 2021) on Noordwijk beach (52.24 °N, 4.42 °E) to monitor the natural sand development around two sea containers (see Figure 1). In addition on a larger scale the dune development around a permanent beach pavilion was monitored for two years (from August 2019 till August 2021) within the CoastScan project (Vos *et al.*, 2017) with a permanent laser scanner.

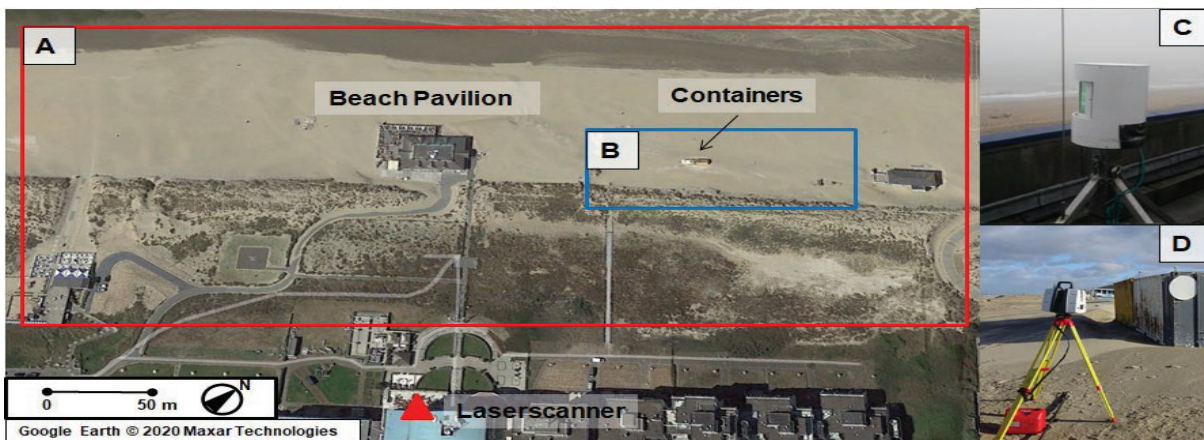


Figure 1: Overview of the Noordwijk study site with (A) area covered by the permanent laser scanner (C and red triangle in A) within the CoastScan project and (B) the study site with containers covered with a mobile laser scanner (D) within the 'Scanex 2020' field campaign.

### 2. RESULTS

Three winter storms with wind speeds up to 39m/s mostly from the South-West, created a typical horse shoe form (Poppema *et al.*, 2021) in the beach morphology around the containers with height difference up to 50 cm (see black lines in figure 2 with the container indicated with the red square). The longer term effect on the dunes is however more difficult to detect as no clear growth areas (see dashed line in figure 2A) can be distinguished in the three months Scanex 2020 field campaign.

The longer term analysis from the CoastScan data shows a more clear pattern in the dune growth (along the black in figure 2b) due to the beach pavilion (indicated with the red square). Figure 2c shows the dune height in aug 2019 and 2021 and clearly shows a dune top growth south of the beach pavilion with absent growth north of the pavilion.

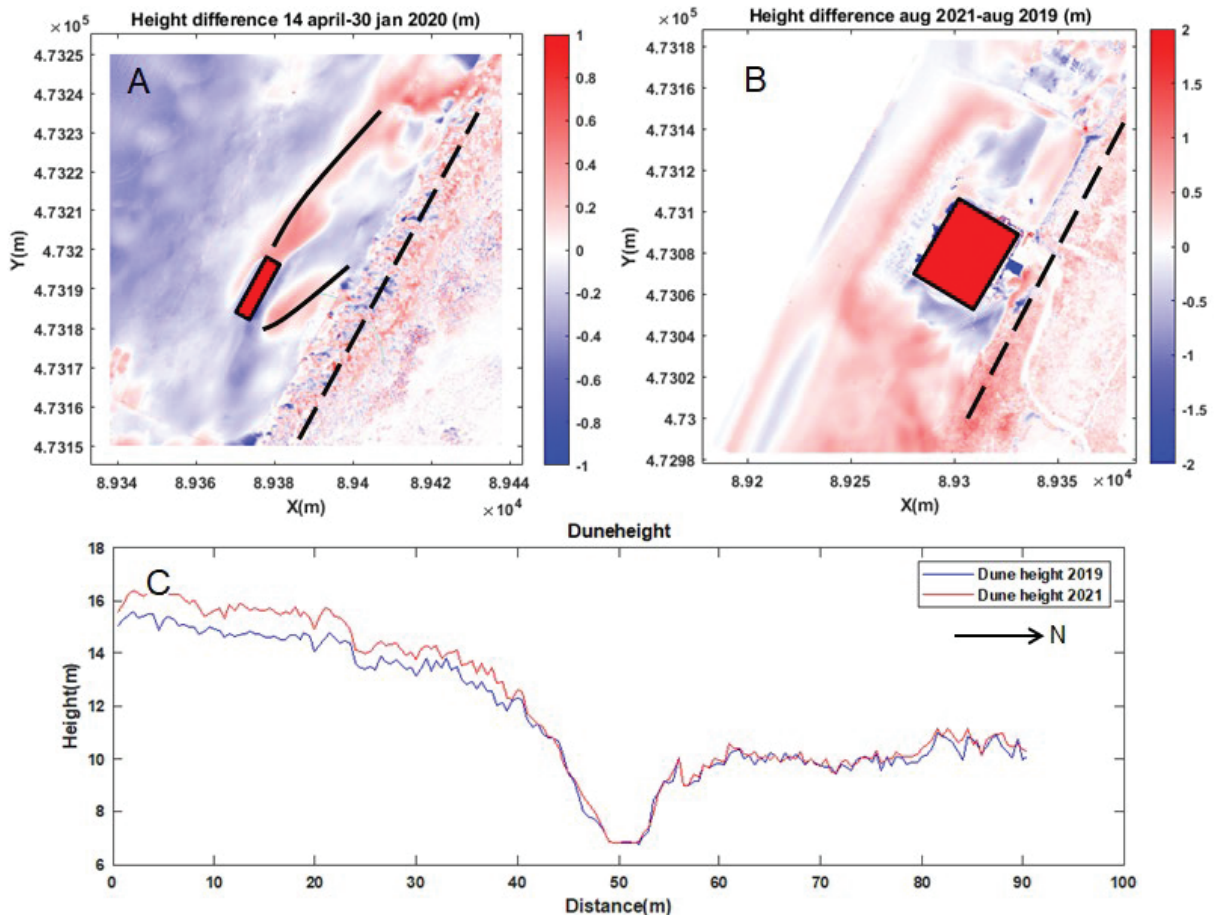


Figure 2: A) Measured beach height difference (m) at the 'Scanex 2020' field site (see Figure 1) between April and January 2020 with the black line indicating the horse shoe effect of the container (red square) on the beach morphology. B) Measured beach height difference between August 2021 and August 2019 (m) around the beach pavilion (red square) with the dune height along the dashed black line displayed in panel C.

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