Dune erosion during storm surges: The realdune/reflex experiment at the sand engine

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1. INTRODUCTION

Storm conditions can lead to excessive dune erosion with potential floods as a consequence. Barrier islands and low-lying countries protected by dunes are especially vulnerable to dune erosion. To properly assess the risks these areas face, a clear understanding of the physical processes during dune erosion is required.

An international field experiment was conducted to study dune erosion during storm surges from November 6 2021 until January 6 2022. on the Sand Engine. During the *Realdune/Reflex* experiment, two prototype un-vegetated dunes of 5.5 m high and 150 m long were built just above the high waterline. Due to a different shoreline orientation and nearshore bathymetry, these dunes eroded differently during moderate storm conditions. 3 storms were captured during the campaign.

This abstract presents preliminary results of morphodynamic change during these 3 storms, by means of profile changes and erosion volumes.

Figure 1: Aerial impression of the field site at the Sand Engine, Kijkduin, the Netherlands

2. FIELD LAYOUT AND STORM CHARACTERISTICS

The first storm occurred on November 7 2021, during the deployment phase of the campaign, resulting in fewer instruments measuring on site. The second storm occurred on December 2nd 2021, and the third storm on January 5th 2022. The latter 2 storms were monitored closely with instruments placed along the central cross section of both dunes (Figure 2). Pressure sensors and velocimeters allowed an accurate quantification of the development of the significant wave height, wave period, and wave direction. Regarding surge levels, the storm of January 5th was most significant. The storm of November 7th came second, and December 2nd third (Table 1).

Storm	$\eta\eta$max $HHHHHH$ (mm)	$\eta\eta$max $SSSSHHSS$ (mm)	HH_{ss},max (mm)	TT_{pp},max (ss)	$TTh0$ $(\circ NN)$
07-11-2021 16:20:00	2.36	2.24	3.04	8.3	321
02-12-2021 00:40:00	2.12	2.03	4.27	9.5	335
05-01-2022 16:20:00	2.51	2.28	4.03	9.6	303

Table 1: Storm conditions of the 3 captured storms. The surge level was measured at 2 nearby wave station (HvH - Hoek van Holland station and SCHE – Scheveningen). The water levels are given with respect to NAP. The wave conditions were recorded at the offshore Europlatform station.

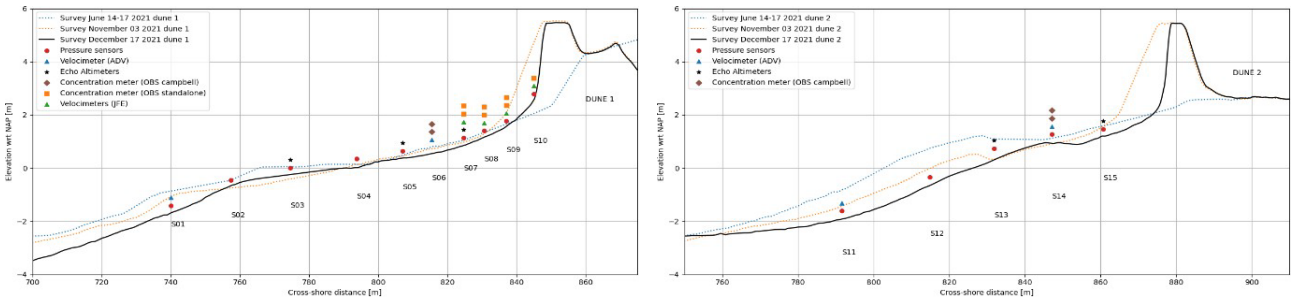

Figure 2: Cross section of both dunes including instruments

3. EROSION QUANTITIES

Before and after each storm, walking surveys were performed for accurate pre- and post- storm profiles (Figure 3). The January storm resulted in significant overwash and, in the end, inundation at dune 2. Using the pre- and post-storm surveys, erosion quantities can be computed for each individual storm (Table 2).

Storm	Erosion dune 1 (m^3 /m)	Erosion dune 2 (m^3 /m)
November 7 2021	7.70	8.52
December 2 2021	6.87	13.35
January 5 2022	8.47	14.09

Table 3: Erosion quantities for dunes 1 and 2 for each of the 3 storms. Erosion was defined as the difference between the pre- and post-storm profile above the 2.0 depth contour.

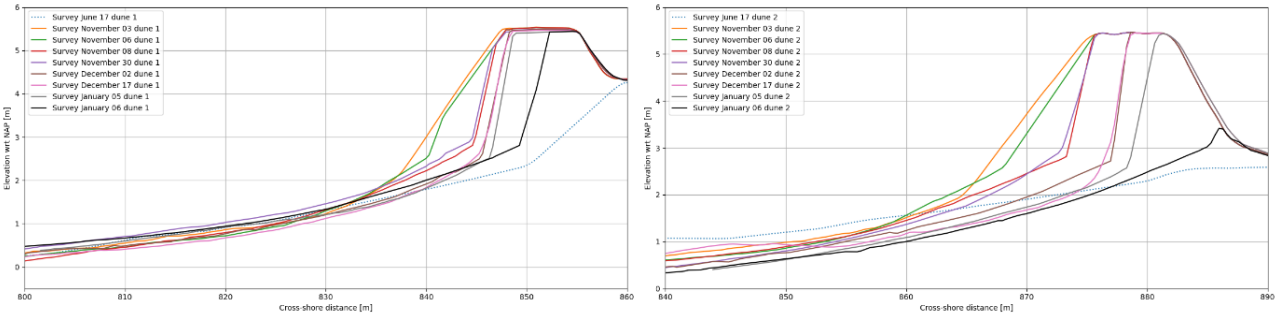

Figure 3: Cross sectional profiles of Dunes 1 and 2 before and after storms

4. CONCLUSION

Initial results show the effect of 3 storms on artificial dunes at the sand engine. Erosion occurred in the collision, overwash, and inundation regime. The storm of 5 January was most significant with respect to surge levels, and also resulted in the greatest amount of erosion at both dunes. Next steps will focus on relating erosion quantities to local wave hydrodynamics.