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TITLE: The initial morphological response of the Sand Engine: A process-based modelling study

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ABSTRACT:

Sand nourishments are presently widely applied to maintain or enhance coastal safety and beach width. Over the last decades, global sand nourishment volumes have increased greatly, and the demand for nourishments is anticipated to increase further in coming decades due to sea level rise. With the increase in nourishment size and the request for more complex nourishment shapes, an adequate prediction of the morphodynamic evolution is of major importance. Yet, neither the skill of current state-of-the-art models for such predictions nor the primary drivers that control the evolution are known. This article presents the results of a detailed numerical modelling study undertaken to examine the model skill and the processes governing the initial morphological response of the Sand Engine and the adjacent coastline. The process-based model Delft3D is used to hindcast the first year after completion of the mega-nourishment. The model reproduces measured water levels, velocities and nearshore waves well. The prediction of the morphological evolution is consistent with the measured evolution during the study period, with Brier Skill Scores in the ?Excellent? range. The model results clearly indicate that the sand eroded from the main peninsular section of the Sand Engine is deposited along adjacent north and south coastlines, accreting up to 6 km of coastline within just one year. Analysis of model results further show that the erosional behaviour of the Sand Engine is linearly dependent on the cumulative wave energy of individual high energy wave events, with the duration of a storm event being more dominant than the maximum wave height occurring during the storm. The integrated erosion volume due to the 12 events with the highest cumulative wave energy density accounts for about 60% of the total eroded volume of the peninsula, indicating that the less energetic wave events, with a higher probability of occurrence, are also important for the initial response of the Sand Engine. A structured model experiment using the verified Delft3D model indicates that wave forcing dominates the initial morphological response of the Sand Engine, accounting for approximately 75% of the total erosion volume in the first year. The vertical tide is the second most important factor accounting for nearly 17% of the total erosion volume, with surge, wind and horizontal tide playing only a minor role.

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