PROMOTING BEACH-DUNE INTERACTION IN THE PRESENCE OF MAN-MADE OBSTACLES

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Introduction

The exchange of sediment between the beach and dunes is of paramount importance for maintaining a healthy and dynamic dune system. At various places along the Dutch coast, this exchange of sediment is hindered by man-made structures such as beach houses and pavilions. Their presence leads to a loss in dune dynamics and dune growth potential. The goal of this project is to find ways to promote sediment transport around, between and below these structures, such that dune dynamics at these locations are (at least partly) restored. This is in line with present-day coastal dune management in the Netherlands that focuses on restoring dune dynamics rather than on continuous maintenance.

Methods

For the first time, this problem was approached by using computational flow dynamics (CFD), rather than field observations or satellite imagery. This different method allowed us to test and compare potential measures that reduce the negative impact of beach structures. Two measures were tested: 1) increasing the distance between structures to allow sediment transport between structures; and 2) placing structures above the ground on poles to allow unhindered sediment transport. Numerical modelling of airflow was done using the simpleFoam steady-state solver in openFOAM, a free open-source CFD toolbox. A simplified coastal profile based on AHN3 measurements serves as a basic mesh, on top of which building objects were placed. In addition to the variable associated with the investigated measure, all situations were tested for six incoming wind directions ranging from 0° (shore-normal) to 75°.

Results and Discussion

Preliminary results for ten 7 x 4 m beach houses show that placing the houses above the ground on poles is the most effective way to promote unhindered flow and sediment transport. The effectiveness of poles expressed in terms of sediment mobility (based on Bagnold's mobility criterion for wind-blown sediments) increases rapidly up to a pole height of 1.5 - 2 m. At heights > 2 m the extra benefit is negligible (Figure 1). Increasing the space between houses to more than 3 m leads to some flow acceleration, allowing sediment to be transported between houses. However, duneward flow and sediment mobility is much lower than in the case of placing structures 1.5 - 2 m above the ground. In addition, much of the sediment is expected to be trapped in tail bars that form behind the houses. Further efforts will focus on the inclusion of a sediment transport predictor, different building types, different wind conditions and a third measure of placing objects farther away from the dune foot.

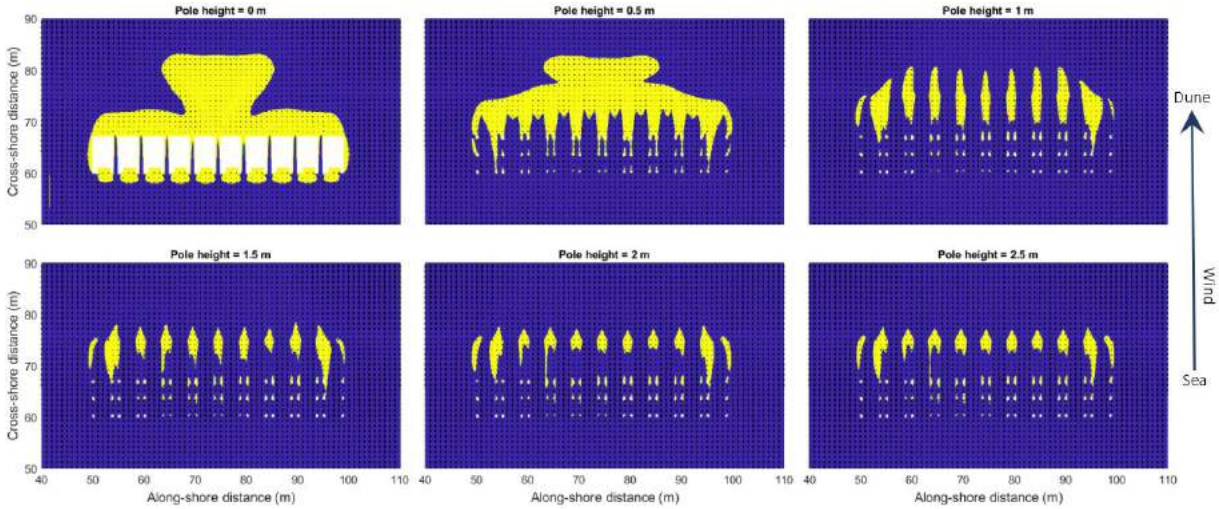

Figure 1. The effect of different pole heights on sediment mobility in the case of shore-normal incoming winds with a reference speed of 10 m/s. Space between houses is 1 m. The yellow area shows where sediment is immobile.