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Monitoring short term aeolian beach sand transport using terrestrial laser scanning

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The topography of sandy beaches, typical for the coast in The Netherlands, is constantly changing because of two related physical processes. First, sand is deposited and eroded by the sea, while secondly sand is transported over the beach and into the dunes by wind. Traditionally, resulting topographic changes on the beach along the Dutch coast are monitored at yearly intervals using airborne laser scanning or by means of GPS profiling. Using such large temporal sample intervals, it is however impossible to directly relate morphodynamic changes to the driving physical processes. Establishing such a direct relation could strongly increase the insight into the processes that are continuously shaping Dutch and other sandy coasts worldwide and would thereby contribute to improved management strategies aiming at maintaining or even extending current coastlines.

For these reasons two experiments were conducted, one in autumn 2009 and one in autumn 2010, In the 2009 experiment a screen of about 10m was placed perpendicular to the prevailing South-Western wind. Because of the screen, wind near the sand surface dropped its force, and saltating sand would be deposited on the ground. The changes in topography in front of the screen and in neighboring areas was monitored using the Faro Photon terrestrial laser scanner, at about 4 hours interval during a total period of more than three days. The resulting topographic changes, in the order only of a few mm/hour at most, could be revealed using a suited cylindrical grid, adaptive to the distance to the scanner. Using the grid, different dynamic trends at different grid point locations could be distinguished. In addition, the grid could be used to directly transform changes in height to volumes of deposited or eroded sand. The results show a clear relation between the gained volume in front of the screen on one hand and the wind velocity and direction on the other hand. Further validation of these results could moreover be obtained by linking both the meteorological data and the sand volume changes to measurements of the amount of sand in transport, as was obtained from so-called saltiphones, that count the number of passing sand grains per unit of time at a height of about 10cm above the ground.

Models describing sand transport indicate that the so-called fetch length could strongly influence the amount of transported sand, given fixed suited wind conditions. The fetch is in this case the distance, in the direction of the wind, between the upwind boundary (water line) and the screen. To assess the influence of fetch, the topography in front of two screens was simultaneously monitored by terrestrial laser scanning in the autumn 2010 experiment. The first screen was placed close to the waterline, while the second screen was placed higher on the beach. It will be analyzed if differences in the accumulation patterns in front of the two screens indeed exist and can be related to the existing transport models.

The results of the first screen experiment, made in 2009, already indicate that terrestrial laser scanning is a suited technique to obtain improved insight in short term (hours to day) morphodynamic processes resulting in topographic signals of only millimeters per hour at most. In order to reach this level of results a sophisticated processing chain is needed however, especially to deal with the harsh environment (rain and strong wind) and the lack of stable targets, that tends to negatively influence the quality of the results.