LIDAR MEASUREMENTS OF SWASH-EVENT BED DYNAMICS

INVESTIGATION OF LIDAR APPLICATION TO MONITOR BEACH EVOLUTION AT THE INTER-SWASH SCALE

The swash zone is the dynamic interface at sandy beaches between the land and ocean that is alternately covered and exposed by onshore- and offshore-directed water movement, the swash and backwash respectively. The challenge associated with the swash zone is the ability to obtain reliable measurements of its bed dynamics at the inter-swash scale, with a spatial resolution of millimetres and a temporal resolution of seconds. As the result, the knowledge about the processes occurring in the swash zone is limited. To overcome the challenge, it was proposed to make use of LiDAR (light detection and ranging), which is an optical remote sensing technology that makes use of laser beams to detect the distance between LiDAR and an object or surface (Figure 1).

To assess if the LiDAR can be used to obtain accurate information on bed level changes at an inter-swash scale, a large-scale wave flume was utilized (Figure 2). Here, a sandy (d_{50}=0.25mm) beach slope (1:15) was artificially created and exposed to irregular JONSWAP wave conditions (H_s=0.55m and T_p=3.50s) while at the same time monitored with a LMS511 2D LiDAR manufactured by SICK AG. The LiDAR was positioned ~5m above the beach slope and was measuring at a frequency of 25 Hz with an angular resolution of 0.1667 degrees.

In the validation section, the LiDAR measurements along the horizontal and vertical axis were compared to other measurement devices. Under the laboratory conditions, it was found the LiDAR error for each axis does not exceed a 5mm margin.

Subsequently, to study the bed level, first, the water level measurements must be separated from the bed level measurements. To achieve this, three different methods were used: varying variance, decreased variance and relative signal strength index methods. In general, none of the described methods could follow the water columns thinner than ~20mm. Nevertheless, the general behaviour of the swash lens uprush and backwash on the beach slope was captured. Besides, it was concluded that to study bed level changes at inter swash scale the water line derived with the observed variance method provided the most accurate results.

Finally, the bed level changes at the inter-swash scale were determined. In total, during the ~30min run, a total of 165 swash events were identified. While the majority of events observed were shorter than 10.5s, other events lasted up to 42s. Almost every swash event induced local bed level changes that exceeded the observed LiDAR error. In addition, the most accretive or erosive swash events induced swash zone morphological changes that were as large as half of the net swash zone morphological change over the 30min period.

As a result, it was concluded that LiDAR is capable of monitoring the morphological evolution of the swash zone in the period of 30min. At the inter-swash scale, most of the bed level changes that occur are below the LiDAR error margin (~5mm). Nevertheless, the shortest possible time scale at which significant bed level changes were observed was 3.4s or roughly the duration of a single swash event. In future research, a more robust water and bed level separation technique should be derived. Further investigation is also needed to examine if it is possible to increase the LiDAR accuracy, either with data manipulation techniques or by using different LiDAR settings.

Figure 1: 2D LiDAR

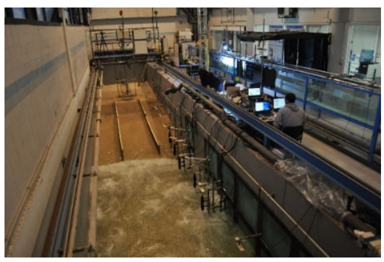
Figure 2: Wave Flume Set-Up

Artis Murnieks

Graduation Date:
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Graduation committee:
University of Twente

Dr. ir. J.J. van der Werf
Dr. ir. E.M. Horstman
M.Sc. S. Dionisio Antonio

UNIVERSITY OF TWENTE.