40,000 waves improve sand transport models

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Over the past few years, University of Twente Ph.D. student Joep van der Zanden has created perfectly identical waves – 40,000 times – in a large 'wave flume' (channel) in Barcelona. Using advanced measurements, he investigated the effect of these waves on the sand at the bottom of the flume. The results of his work included a detailed description of the effect of breaking waves on the movement of water and on the shifting sands of the seabed. The knowledge obtained in this way is essential if we are to improve existing models and, ultimately, make beach nourishment operations more efficient. Mr van der Zanden will be defending his PhD dissertation at the University of Twente on Thursday 9 December.

More sand is being washed away from beaches along the Dutch coast than is being deposited. Accordingly, each year, the Directorate-General for Public Works and Water Management in the Netherlands nourishes around 12 million cubic meters of sand onto zones just out from the coast. This sand then washes up onto the beach, thus reinforcing the coastline.

Existing sand transport models are not precise enough to accurately determine how much sand has to be nourished into which sites to achieve optimal coastal protection. Accordingly, this is still mainly based on experience. A major limitation of current models is that they fail to take sufficient account of the complex transport behaviour of sand in the surf zone, where waves break, and in the swash zone, where the waves run up and down the beach. As a result, in some areas, the amount of sand that is transported in practice can differ from the predicted values by a factor of two. The aim of Joep van der Zanden's PhD research was to improve our understanding of the physical processes involved in sand transport in the surf and swash zones, in order to improve existing sand transport models and thus make beach nourishments more efficient.

40,000 waves

At a 100-metre-long wave flume in Barcelona, the PhD student created identical waves over 40,000 times. He then used a variety of measurement techniques to investigate the effect of these waves on the 240 cubic metres of sand covering the bottom of the wave flume. For instance, he measured the amount of sand stirred up from the bottom (by the swirling currents generated by the waves) and recorded where this eventually settled.

Mr van der Zanden used a range of instruments to measure the concentration and speed of sand particles in the water, he also examined changes in the underlying sand layer, and measured the water pressure at various points in the wave flume. Thanks to a measuring instrument developed at the University of Twente, it was also possible – by means of electrical measurements – to measure the amount of sand in the water just a few millimetres above the bottom (a layer that plays a crucial part in the transport of sand).

One of his research findings was that the turbulent flow structures caused by breaking waves pick up more sand than had previously been assumed. The sand on the seabed moves slowly towards the beach, while any sand that is stirred upwards tends to move away from the coast. Ultimately, it is the interaction between these two processes that determines how much extra sand is deposited on the beach. Thanks to Mr van der Zanden's research, we now have a much better understanding of these fundamental processes, and our sand transport models can be further refined.

Provided by University of Twente