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Field experiments with painted sediments – a tool for understanding coastal processes.

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Surf and the swash zones comprise regions of the coastal zone where waves dissipate or reflect their remaining energy after propagation from the open sea towards the coast. Within this region most of the sediment transport occurs giving rise to the generation of rapid coastal changes. Current understanding of the morphodynamics in this region is limited. Therefore, swash/surf zone hydrodynamics and sediment transport have been active topics of research over the past decades. Several laboratory experiments have been conducted to quantify coastal processes over the past decades. However, few experiments have been carried out in the natural environment.

Analysis of painted sediments was carried out for the current study. Sorted particles with the following diameters were used: 1–2.5 cm (yellow), 2.5–5 cm (red) and 5–10 cm (blue). The sediments were painted with non-fluorescent, water and wear resistant colors, stacked in piles and placed at depths of 0.5–10 m at several study sites all along the Estonian coast. The locations were positioned and were photographed. The sediment piles placed in the sea were monitored at least once after an intense storm or once before and after the storm season. Additional tests were carried out on the swash zone, where the sediments were accumulated in a continuous line from -0.5…+1.3 m. Distances from the initial source of the sediments as well as the elevation of the painted sediment particles was calculated and analyzed. Recorded changes were compared with the measured and modeled wave parameters (by using RDCP and simple point model).

We may conclude that most storm waves break at depths of 2–4 m. However, this zone might extend seaward during strong storm events and wave braking may occur even at 6 m depth. There is very active sediment transport in this zone and particles with a 1–10 cm diameter are usually transported towards the shore. We were able to record that the painted sediments moved up to 20 meters towards the shore during one singe extreme event (wind speed up to 33 m/s, waves up to 5.2 m).

The sediments accumulated as a continuous line from -0.5 m to 1.3 m started to move along the shore towards the nearby spit. In the first 15.5 hours, yellow, red and blue sediments moved up to 2.4 m/h, 2.4 m/h and 1.5 m/h, respectively. Wind speed attained 7.1 m/s, waves (Hs up to 1.1 m) approached the shore at a sharp angle, which is favorable for long-shore transport during this 15.5 hours period. We were able to find a few painted sediments as far as 350 m (red) towards the tip of the spit three months later. The furthest yellow and blue particles were found 330 and 285 m from their initial location. Therefore, the average travelling speed was 0.13–0.16 m/h.

The fact that we were able to find many sediment particles in such a dynamic environment (even three months later!) indicates that the mobile layer of sediments on the gravel shores on the Baltic Sea seems to be smaller that initially expected. This study was able to confirm only that typically a 20–40 cm thick layer is mixed even during strong storms and in the most mobile and energetic environments for gravel shores.