MODELING WAVE-DOMINATED AND SANDY SHOREFACE MORPHODYNAMICS UNDER SEA-LEVEL RISE

Coastlines are expected to retreat due to a globally accelerating sea-level rise (SLR). To anticipate future land loss, it is important to know how coastal zones will react to a rising sea, both now and on the long term. This study focuses on the development of a morphodynamic model that describes the transient development of a sandy wave-dominated shoreface. We then subject this model to SLR to study how this affects the coast.

The presented morphodynamic shoreface evolution model is based on descriptions of wave-induced sediment transport mechanisms, consisting of a slope-induced component directed offshore, and onshore-directed components resulting from shoaling of waves. Assuming alongshore uniformity, these descriptions of sediment transport are coupled to bed development through the Exner equation (following Ortiz and Ashton, 2016). This results in a PDE bounded by the shoreline and a point (far enough) offshore. The onshore boundary is a moving boundary obeying a so-called Stefan condition. Furthermore, a parametrized onshore overwash flux is added to the model formulation to represent back-barrier sediment deposition, which is widely recognized as a driving mechanism behind barrier beach persistence.

The model allows for investigation of dynamics of different parts of the coastal tract. This is done for three rates of SLR based on current predictions, and two different backslopes (i.e. the slope of the regional profile). The profile shows cliff formation for a steep backslope and develops a flat for a mild backslope. Furthermore, it is shown that the lower shoreface profile develops an out-of-equilibrium shape.

The depth at which only negligible bed level changes occur (Morphodynamic Depth Of Closure, MDOC) is derived from the model simulations. These results show that the MDOC for the steep backslope case is deeper than for the mild backslope. The magnitude of the MDOC is in disagreement with earlier estimations for the same wave conditions given in the literature.

Model simulations show that the long-term retreat rate of the boundary depends on the regional slope and only initially approximately follows the Bruun rule. Over time, this results in faster retreating coasts for shallow regional slopes (Figure 1) and slower retreating coasts for steep regional slopes than predicted by the Bruun rule. This relaxation behaviour is in line with earlier findings. Finally, it is noted that the length of the active profile (the distance between the shoreline and the MDOC) relaxes over time to a constant width (Figure 1).

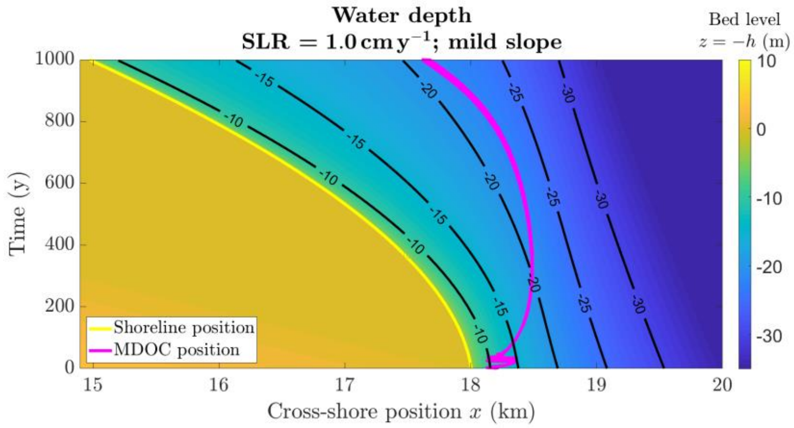

Figure 1: Simulated water depth development with SLR = 1.0 cm y^{-1} on a mild backslope

Ortiz, A.C., Ashton, A.D. (2016). Exploring shoreface dynamics and a mechanistic explanation for a morphodynamic depth of closure. J. Geophys. Res. Earth Surf. 121, 442–464. https://doi.org/10.1002/2015JF003699

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