Intertidal beach morphodynamics of a macro-tidal sandy coast (Belgium)

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The intertidal zone plays an important role in the protection of the coast. It is a very dynamic area subject to waves, tide, and wind and topographic changes can be large over a short period of time. For macro-tidal coasts (tidal range > 4 m) like the Belgian one, tide is an important factor in the intertidal beach morphodynamics but it remains unclear what specific hydrodynamic conditions lead to topographic changes. This is mainly due to a scarcity of reliable field data of sediment transport and beach topography. This study investigates the intertidal beach morphodynamics based on extensive measurements of hydrodynamics, sediment transport, and beach topography resulting in a conceptual model of hydrodynamic forcing and topographic response. Two study sites along the Belgian coast are examined: a natural, multi-barred beach (Groenendijk) and a managed beach with a featureless intertidal zone (Mariakerke).

The monthly to seasonal dynamics in beach topography is investigated based on multiannual monthly cross-shore beach profiles. It is found that topographic changes on this scale are mainly event-driven with, in general, erosion during energetic events and beach recovery in between. The ridges and runnels at Groenendijk move onshore and become more pronounced during energetic conditions, while the intertidal beach topography is smoothened during calm conditions. Monthly variations in intertidal beach volume are on average 2% of the total beach volume and they can be up to 7% for energetic (non-storm) events. There is a large alongshore variability in topographic response to hydrodynamic forcing and this response can even be opposite over a distance of tens of meters.

In comparison to the nearshore hydrodynamics and sediment dynamics it is found that the intertidal beach grows when waves are small (wave steepness < 0.010), whereas it erodes when waves are large (> 0.025). For medium wave steepness (0.010-0.025) this is opposite, which is attributed to a sudden rise in sediment supply. This rise is likely related to waves breaking over the sandbanks in front of the coast and at beaches southwest of the study sites.