SCALDIS-COAST: A NUMERICAL MODEL FOR LONG-TERM MORPHOLOGY OF THE BELGIAN COAST USING THE TELEMAC-MASCARET SYSTEM

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INTRODUCTION

The sea level rise poses a growing threat to the coastal safety. The Flemish Authorities launched the *Complex Project Kustvisie* (CPKV) to define the overall long-term coastal defense strategy for the Belgian Coast together with all involved stakeholders. In order to strengthen the coastal defense and investigate different future scenarios in an efficient, flexible and integrated way, a reliable estimate of the sediment transport in the coastal zone remains of considerable practical importance. In the present study, a 2D morphodynamic model (Scaldis-Coast) was developed to provide a tool which can be employed to simulate the long-term morphological evolution of the Belgian Coast.

DESCRIPTION OF THE STUDY AREA

The Belgian coast is characterized by sandy bed with a fairly uniform bathymetry and gentle slope with shore connected tidal sandbanks. The semidiurnal macro tidal regime of about 4 m range, produces a net tidal current from southwest to northeast. The wave climate is dominated by waves coming from the North and West quadrant, which produce net longshore sediment transport in the same direction as the net tidal current.

METHODOLOGY

The so-called Scaldis-Coast numerical model was developed within the TELEMAC-MASCARET system, and meshed with based on an unstructured grids which fit the land boundary closely (Figure 1). The computational domain spans from the French coast near Calais to the Dutch coast between the Eastern Scheldt and the Grevelingenmeer, including the Eastern and Western Scheldt estuary to model the tidal wave propagation properly. The offshore boundary is at a distance of about 30 km from the coast. The resolution of the model varies from 750 m offshore to 20 m nearshore with special refinement around complex geometries like breakwaters, but also at locations with steep slopes in the bathymetry. Before the model is used for morphological simulation, it has been calibrated and validated in terms of hydrodynamics and waves. Bed load and suspended sediment transport are calculated using the classical formula of Soulsby - van Rijn, which is able to account for coupled wave- and current-induced transport (Soulsby, 1997).

According to an input reduction scheme (Zimmermann et al., 2012), a representative diurnal tide is firstly selected. However, due to the broad domain of the model, the wind generated waves inside the model play a dominant role in the wave-driven alongshore sediment transport especially during western winds. Consequently, the reduction of wind input was found inapplicable in this study when reducing the wave input (Kolokythas et al., 2020).

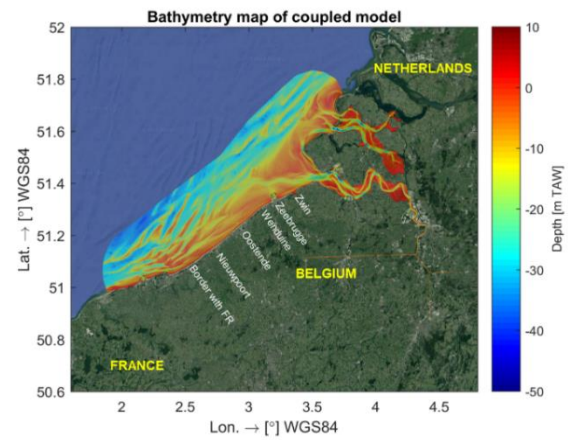

Figure 1 – Model domain and bathymetry

Therefore, the model was run with 10-year brute wind and wave conditions, and the mean annual net alongshore transport was derived. A representative half year period (07/11/2013 – 09/05/2014) was subsequently selected based on the comparison of alongshore sediment transport in Figure 2. Modelling of 10-year morphology was finally achieved by the time series brute wave and wind conditions from the representative half year in combination with a constant morphological acceleration factor (MorFac) equal to 20.

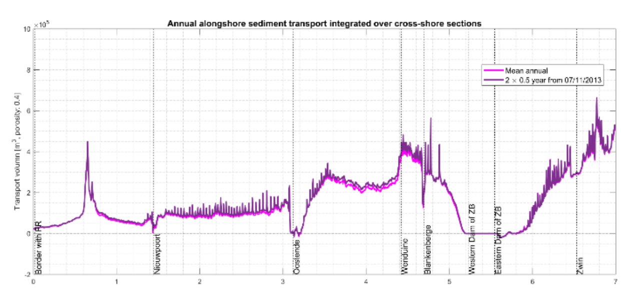

Figure 2 – Comparison between mean annual net transport derived from the 10-year modelling and modelled net transport of the selected representative half year from 07 November 2013

MORPHOLOGY VALIDATION

In order to perform morphology validation, one-year bed evolution in front of Wenduine after nourishment, and sedimentation in the navigation channel of Blankenberge marina during the Ciara Storm have been simulated by the model.

In the validation case of erosion around Wenduine after nourishment, a calculation of net erosion is performed within the magenta box, which gives a value of 160,000 m^3 for the model, only 10% larger than 145,830 m^3 observed from the bathymetry survey (Figure 3).

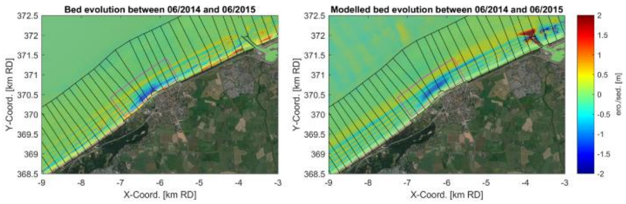

Figure 3 – Observed and modelled erosion in front of Wenduine

In addition to the erosion, the model shows a strong sedimentation in the Blankenberge access channel. In February 2020 Storm Ciara caused an instantaneous sedimentation of the Blankenberge access channel. The sedimentation-erosion patters not only show a good qualitative agreement, but also demonstrate a high level of quantitative accuracy (Figure 4). A calculation of net erosion within the dashed polygons suggests a value of 42,000 m^3 for the model, only 3.7% less than 43,600 m^3 obtained from the measurement.

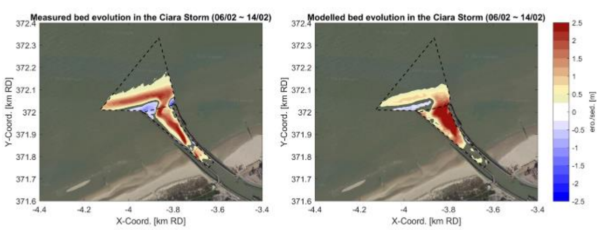

Figure 4 – Observed and modelled sedimentation in the channel of Blankenberge during the Ciara Storm

CONCLUSIONS AND ONGOING RESEARCH

A morphodynamic model was developed for the Belgian Coast. The morphology validation has shown a good capability of the model to reproduce observed morphological changes within both yearly and weekly time spans.

In combination with MorFac 20, the representative tide and time series wave climate of the representative half year have been used to drive the model to simulate 10-year morphology of the Belgian Coast. Currently, morphological changes within the decadal scale are being validated.

Furthermore, ongoing efforts have been made to incorporate cross-shore transport into TELEMAC, and this development is currently under validation. In the present study, only sand fractions are modelled. The morphodynamic model is also expected to include sand-mud interactions to cope with mixed sediment transport.

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