ASSESSING THE IMPACT OF SEA LEVEL RISE AND LONG TERM COASTAL PROTECTION STRATEGIES AT THE BELGIAN COAST

Bart Verheyen, IMDC, bart.verheyen@imdc.be
Annelies Bolle, IMDC,annelies.bolle@imdc.be
Ali Dastgheib, IMDC, IHE-Delft , ali.dastgheib@imdc.be
W. Alexander Breugem, IMDC, alexander.breugen@imdc.be

INTRODUCTION

The Belgian coast is a vulnerable low lying densely populated area and. The coastal protections are currently upgraded based on the Coastal Safety Masterplan. This plan protects against a 1000-year storm including a sea level rise of up to 30 cm by 2050 based on the climate scenarios available at the time. Most projections now show that the sea level will rise more strongly and faster after 2050 and that additional efforts are needed in order to keep protecting the entire coast against flooding after 2050. The search for complementary longer term coastal protection strategies was therefore initiated in Belgium in 2017 by the setup of the Coastal Vison project (Vlaamse Regering, 2017).

LONG TERM COASTAL PROTECTION STRATEGIES

The Coastal Vision project aims to define a long term coastal protection strategy up to +3m sea level rise. This is done by exploring different spaces in which potential future coastal protection systems can be developed in combination with other opportunities. This resulted in different alternatives varying between allowing the beaches to retreat up to creating barrier islands.
Determining the most appropriate strategy is however a challenging task due to the uncertainties related to the long term processes and the balance needed between the level of detail required to assess the strategies and the strategic level of the studies.

ASSESSMENT APPROACH

A cocreation process was used during which, together with many stakeholders, the alternatives were gradually reduced in number and optimized with increasing detail in an iterative process based on an assessment framework. As input for this process, a toolbox was developed consisting of various types of models to analyse the impact of sea level rise on the present condition of the coast and the adapted condition including each coastal protection strategy alternative.
The toolbox consists among others of a coastal safety tool to assess the safety of a coastal profile against a defined storm and determine design dimensions of measures (Consortium Hoogtij(d) (IMDC, ORG, Arcadis) (2023b)) and a 2D hydromorphological model of the Belgian coastal area (Consortium Hoogtij(d) (IMDC, ORG, Arcadis) (2023c)). The model results are used among others to assess impacts on hydromorphology, required sand volumes and maintenance volumes for cost estimates, and nautical impacts. In order to apply the model tools in this strategic study many assumptions had to be made (see the discussion).

RESULTS

The assessment results and the impacts of sea level rise are illustrated by a selection of the model results.
1) The safety assessment with sea level rise shows whether a coastal section is protected from combined dune erosion and coastal flooding for the design storm and is illustrated for the situation of 1 m, 2 m and 3 m sea level rise in Figure 1. It can be clearly seen how with increasing sea level the (present) coastal protection is insufficient.

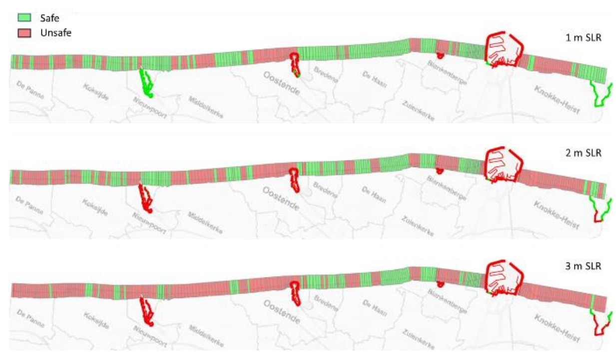

Figure 1: Results of the safety assessment with sea level rise indicating whether a coastal section along the Belgian coast can protect against the design storm and is safe (green) or not (red).

2) The hydrodynamic and wave models result in changes with sea level rise in tidal amplitude and phasing, indicating changes in tidal asymmetry. Furthermore the storm conditions seem to be impacted by sea level rise depending on wave direction. After sea level rise, sand banks have a different impact on reducing wave height for southwestern versus northern storm conditions.
3) Also the sediment transport and morphological processes are impacted by sea level rise. This is illustrated by the impact on sediment transport in the present situation and with sea level rise in Figure 2. A general trend can be observed with increased longshore transport with sea level rise showing local variations attributed to different sediment transport processes present. Next to assessing the present situation, also adaptation alternatives have been evaluated with the sediment transport and morphological model. During the cocreation process, some of the alternatives contained more space for measures by shifting the coastline seaward, making it possible to create different coastline orientations within the available space. Sediment transport results indicated that by doing so the longshore transport and the transport gradients could be reduced, also with higher sea level rise (Figure 3).

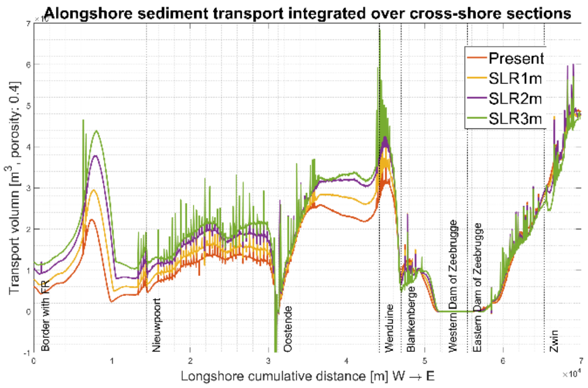

Figure 2: Longshore sediment transport along the Belgian coast for the present situation without sea level rise (red) and 1m (yellow), 2m (purple) and 3m (green) sea level rise.

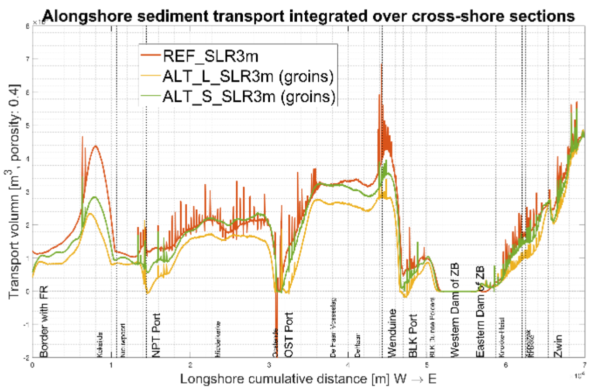

Figure 3: Impact on the longshore transport along the Belgian coast for the present situation with 3 m sea level rise (red) and various alternatives including seaward shifted and different orientated coastline (green and yellow).

DISCUSSION

Assessing long term coastal protection strategies includes many uncertainties such as the sea level rise and rate, the adaptation of coastal profiles and sea bed including sand banks and tidal gullies due to the sea level rise, potentials of dune growth, impact of climate change on wind and storminess, etc. Many assumptions were therefore made during the assessment.

The impact of sea level rise is discussed more in detail, more specifically the application of a specific sea level rise situation (as a snapshot in time) to assess the evolution of the present situation and alternatives. For this study on strategic level, assessing different alternatives within limited time, models were either not advanced enough or it was not deemed feasible due to computational cost to assess the long term evolutions with sea level rise.

Regardless of the uncertainties of the evolution with sea level rise, the assessment in Coastal Vision project provided enough insight to select the most appropriate strategy in terms of the available space that will be reserved to develop the coastal protection. However due to these uncertainties in time of the evolution of the coastal system, the actual design and roadmap of implementing this coastal protection can not be determined yet. Therefore, an adaptive pathway is proposed including tipping points and action plans.

To set up the tipping points and action plan the assessment results are however very useful. This is illustrated by linking the presented model results and adaptive planning approach: 1) The safety scan results show where priorities need to be set and form the first set of tipping points when action is required in certain coastal sections, also a first step of gradual adaptation, continuing measures from the Coastal Safety Masterplan, can be determined. 2) The results from the hydrodynamic models emphasize the need to continue monitoring and identify hypothesis on changes in tide and wave impact to further follow up. 3) The sediment transport results show the potentials of alternatives to reduce the longshore part of the sediment transport. However further research is needed to account for long term processes such as the evolution of the coastal profile and sea bed in time and the influence of cross shore transports. The results also point out the need for more integrated modelling of different processes in space and time and to continue monitoring.

The results of these first set of actions will help defining the further steps in building the coastal protection within the allocated space, including input for the setup of new action plans in the future.

CONCLUSION

The selection of a long term coastal protection strategy requires long-term assessment of different processes introducing many uncertainties such as the rate of sea level rise and the adaptation of the coastal system to it.

The Coastal Vision project shows that the impact of sea level rise can be examined with modelling tools, allowing to make a selection on required strategy. However, the assumption made on snapshot modelling of specific sea level rise levels implies uncertainties as how the actual development in time will be. The results can therefore not be used to develop a detailed pathway, but rather allow for the setup of an adaptive pathway to implement and follow up the coastal protection in time indicating what are the tipping points to take action and the attention points for monitoring and further research.

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