Towards sustainable sediment management and estuary functioning of the Upper Sea Scheldt based on a state of the art modelling approach

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Introduction: The Upper Sea Scheldt (Flanders, Belgium) is the upstream part of the Scheldt estuary. The estuary extends from the North-Sea in the Netherlands to the shipping locks in Ghent, with a total length of 160 km. It is characterized by a high suspended sediment concentration which has a detrimental effect on light penetration (and hence primary production). This is partly the result of intensive dredging and sand extraction. In 2016 a 'Sustainable Management Plan' has been implemented for the Upper Sea Scheldt. In this strategy the dredging activities are directed to the zones where waterway sections need to be managed for navigation purposes. In addition, several pilot projects are realized in which sediment was successfully reused to reshape sections and divert currents to maintain these sections [1]. These actions however are not sufficient to tackle the challenges the system is faced with due to continued dredging practice more downstream in combination with the cumulative effects of other works.

Methods : With the 'Integrated Plan Upper Sea Scheldt' De Vlaamse Waterweg, the responsible waterway manager, aims at improving the ecosystem functioning in combination with habitat improvement and navigation functions. To develop and evaluate the Integrated Plan a state of the art modelling instrument [1] (including a hydrodynamic model, sediment transport model, ecosystem model, higher trophic level model and nautical evaluation) combined with systems theoretical approaches was developed. It was used to learn about the system response to changing boundary conditions and physical interventions. Various measures (i.e depolderings, bend cut-offs, flood control areas with controlled reduced tide, narrowing of the main channel, flood gullies) have been combined into three alternatives (1: minor adjustments to the river, 2: including limited depolderings and bend modifications, 3: larger depolderings and more extreme bend modifications) and evaluated with the modelling instrument.

Results: The integrated analysis of the results of the three research alternatives proved that depolderings are an effective way to mitigate the challenges the estuary is faced with. Besides a reduction of the tidal range, the depolderings also act as a sink for sediment, resulting in a drop in suspended sediment concentrations. This in its turn has a positive effect on the light climate and primary production. Based on a long-term morphological assessment it is expected that the large-scale measures have a long longevity.

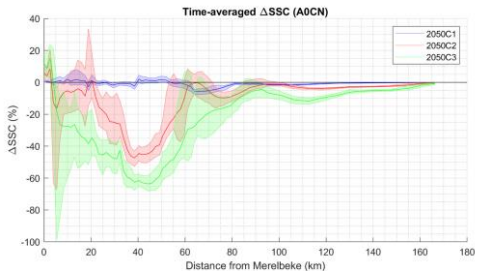

Fig. 1: *Difference in SSC compared to a reference situation (in %) for the three researched alternatives [2]*

Discussion: In the investigated alternatives, a large set of measures are included. In practice, a more gradual realization/implementation of depolderings is more likely and also desired. A gradual construction allows for settling of sediment in order to create a desired mix of habitat types and prevent drowning of certain habitat types. The results from the model instrument also indicate that depolderings are beneficial with respect to flood protection and can compensate for a shortening of the estuary (introduced for navigation). The results from the modelling instrument will be further used to formulate a vision for a sustainable and balanced multifunctional system.

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References: [1] De Beukelaer-Dossche et al. (2022) *Martec Proceedings;* [2] Bi et al. (2021) *FHR Reports, 13_131_18*