The influence of shoal margin collapses on the morphodynamics of the Western scheldt Estuary

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1. Introduction

Channel bank failure and collapses of shoal margins have been recorded systematically in Dutch estuaries for the past 200 years. Between 1800 and 1978 more than 1000 large failures with sediment volumes up to a million cubic meters were documented in soundings of the Eastern and Western Scheldt estuaries (Wilderom 1961-1979). In many locations collapses reoccur at intervals of several years to decades. The objective of this study is to investigate how locations, probability, type and volume of channel/ shoal margin collapse affect the morphodynamics at the channel-shoal scale.

2. Methodology

We study the influence of shoal margin collapse on the morphodynamics of the Western Scheldt Estuary by using an existing Delft3D model schematisation of the Western Scheldt (Van Schaick, 2015). The model is setup around the tidal flat of Walsoorden, a location subjugated to shoal margin collapses in the last decade. Bathymetry measurements of 2013 by Rijkswaterstaat and the Flemish government are used as the initial conditions (Figure 1). We model the morphological development for a period of 10 years, i.e., half year hydrodynamic simulation with a morphological acceleration factor of 20, and use the Van Rijn et al. (2004) transport formula.

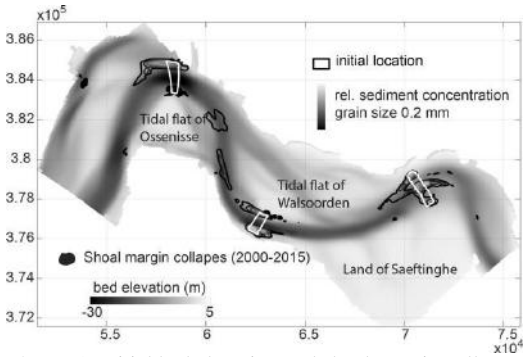

Figure 1. Initial bed elevation and shoal margin collapse locations for the last 15 yrs. Contour lines show the distribution of collapsed material after 10 years.

We test several settings regarding the influence of shoal margin collapses on the development around the tidal flat of Walsoorden; i) grain-size, ii) location of the collapsed deposit, iii) volume of the collapse, and iv) the role of mud.

3. Results & Discussion

The model outcomes show that the morphological development of the Western Scheldt Estuary is affected by sediment deposited in the northern or southern part of the channel that is transported downstream or upstream, respectively (Figure 1). Finer sediments are transported further away from their initial location, but also in a different direction. For example, finer sediments are transported into the northern side channel downstream at the tidal flat of Ossenisse. The available sediment volume from the shoal margin collapse determines the acceleration of the formation of new bars/shoals at the tidal flat of Walsoorden (Figure 2). This has implications for navigation of ships towards the Antwerp port, because of decreasing channel width by the new bar. Inclusion of mud fraction in the model increases the rate that the former shoal margin collapse is filled again, but also limits channel widening.

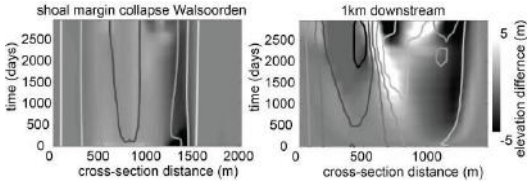

Figure 2. The elevation contour lines and difference in elevation for a model run with a collapse volume of $1.0x10^5$ m^3 and $1.0x10^6$ m^3 shows channel widening at the collapse (left) and accelerated bar development downstream of the larger shoal margin collapse (right).

4. Conclusions

We conclude that shoal margin collapses locally affect the morphodynamics of the Western Scheldt leading to formations of bars up or downstream depending on the location in the cross-channel and along the channel.

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