PERTURBATION EFFECT OF SHOAL-MARGIN COLLAPSES ON THE CHANNEL-SHOAL MORPHODYNAMICS IN THE WESTERN SCHELDT

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Aim

Shoal-margin collapses of 0.05- 1 Mm^3 have occurred in the Western Scheldt more than five times per year for the past 50 years. In the past such collapses caused dike- and bank-protection failures. The present effects of these collapses on the morphodynamics are unknown. One potential effect, increased dynamics of channel-shoal interactions, could impact habitats and navigability. The processes of shoal-margin collapses are not included in numerical morphodynamic models while other events as well as human interference, such as dredging and dumping, cloud the observed morphodynamic effects in the field. 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.

Method

We implemented an empirically validated parameterization for shoal-margin collapses and tested their effects on morphodynamics in a Delft3D schematization of the Western Scheldt estuary (Netherlands). Near-field and far-field effects on flow pattern and channel-shoal morphodynamics were analyzed for a control run without collapses against three sets of scenarios with collapse events over 40 years of morphological development: 1) run including the observed shoal-margin collapse of 2014, 2) run with initial collapses on various locations deemed to be susceptible to collapses, and 3) our novel probabilistic model producing collapses over a time span of decades.

Results

Results (Figure 1) show that single shoal-margin collapses only affect the local morphodynamics in longitudinal flow direction and dampen out within a year for typical volumes of 0.1 Mm^3. When larger disturbances reach the seaward or landward sill at tidal channel junctions over a longer time span, the bed elevation at the sill increases while the wetted cross-section of the channel junctions decreases. The extent of far-field effects is sensitive to the grain size of the deposit, with finer sediments being transported farther away. The location of the deposit, resulting from the collapse, across the channel matters for subsequent redistribution of the sediments along the channel. The rate of redistribution is highest for the strongest tidally averaged flow. New model results also imply that disturbances caused by dredging and dumping may likewise affect the dynamics of channel junctions, a phenomenon that we are currently testing.

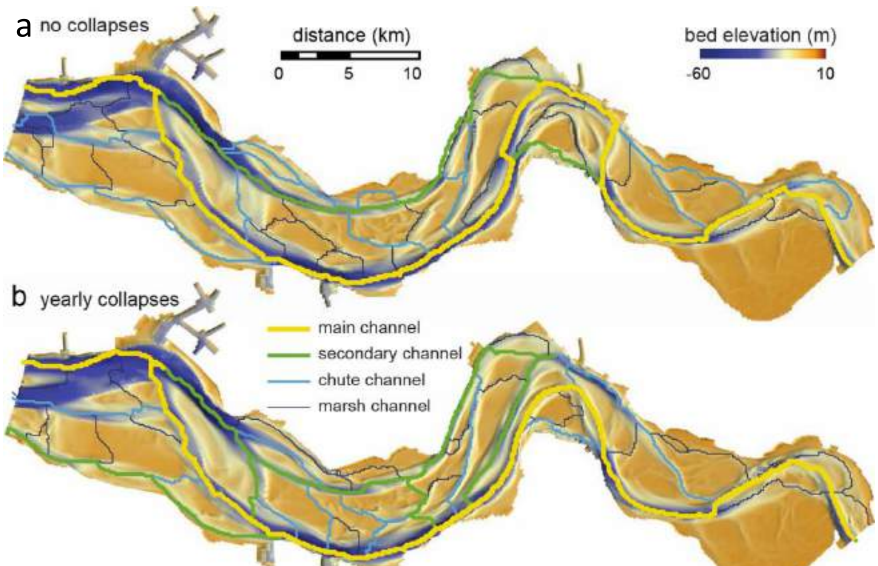

Figure 1. Various network scales for a) the control run without collapses and b) yearly collapses show that channels shift between scales and change their location after 40 years of morphological development.