Regime shifts in a D3D schematized Scheldt model: recent progress

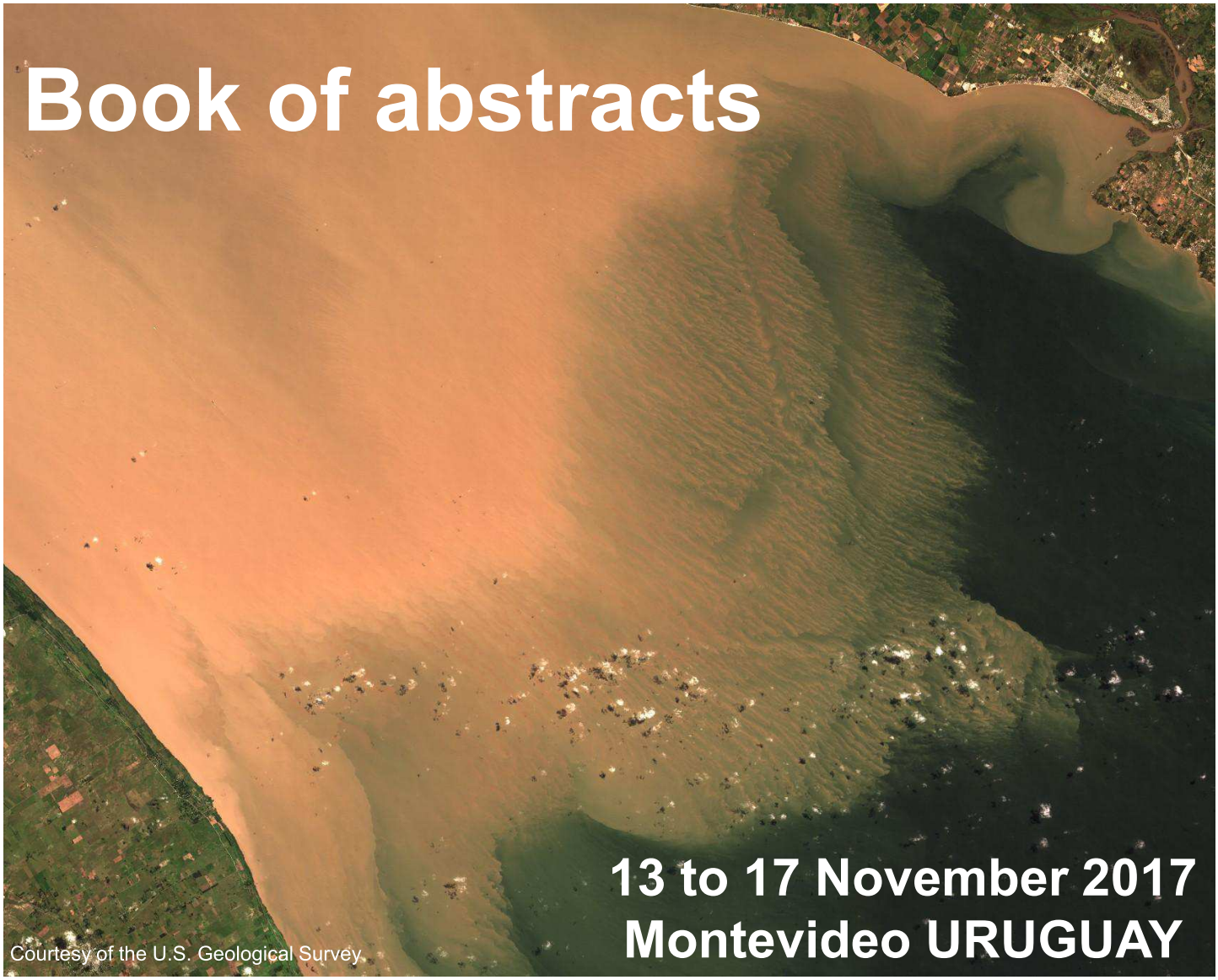
De Lucas Pardo, Miguel; Dijkstra, Y.; van Maren, Bas; Vroom, J; van Kessel, T; Winterwerp, Han

Publication date
2017

Citation (APA)
De Lucas Pardo, M., Dijkstra, Y., van Maren, B., Vroom, J., van Kessel, T., & Winterwerp, H. (2017). *Regime shifts in a D3D schematized Scheldt model: recent progress*. 73-74. Abstract from INTERCOH 2017, Montevideo, Uruguay.

INTERCOH 2017
Montevideo - Uruguay
November 13 - 17

14th International Conference on Cohesive Sediment Transport Processes



imfia

FACULTAD DE INGENIERIA

UNIVERSIDAD DE LA REPÚBLICA URUGUAY

Fundación Julio Ricaldoni
INGENIERÍA EN EL URUGUAY

Regime shifts in a D3D schematized Scheldt model: recent progress

M A de Lucas Pardo[1], Y Dijkstra[1,2], B van Maren[1,2], J Vroom[1], T van Kessel[1], J C Winterwerp[1,2]

[1] Deltares

[2] Delft University of Technology

Abstract

The Ems and Loire evolved into hyper-turbid estuaries in the course of the 20th century. Winterwerp et al. (2013 a, b) argued that narrowing and deepening of these rivers induced a regime shift towards these hyper-turbid conditions. This regime shift was presumed to be driven by a positive feed-back between tidal amplification, tidal asymmetry and sediment-induced drag reduction. As also the Sea Scheldt was/is subject to narrowing and deepening, Winterwerp et al. reasoned that also this river may be at risk to become hyper-turbid.

Currently, these arguments have not yet been sustained with quantitative data and/or model results. Therefore a number of in-depth studies have been initiated analysing such a regime shift. The study in the current report is aimed at contributing to these studies and the discussion on the causes of these regime shifts. The objective of this work is to assess whether a regime shift towards hyper-turbid conditions can be simulated with a simple state-of-the-art process-based numerical model. For this purpose, we have developed a schematized Delft3D model of the Sea Scheldt.

Several model configurations were tested aiming to observe sediment accumulation in the estuary and, eventually, a transition to a hyper turbid regime. These model configurations are defined by the inclusion of certain sediment transport processes. These are: the initial presence of sediments at the bed of the river; erosion and deposition of sediments from the water column to the bed and vice versa; the type of bed model (we have tested the standard D3D bed model and the buffer layer model of D3D) and the associated sediment transport processes (the inclusion of a fluff layer and of a deposition efficiency term is the main difference); in none of the simulations, the bed level is updated, i.e. all sediments depositing on the bed are taken into the bed, but without bed level changes.

The table below gives an overview of the model configurations tested in this study, where the sediment transport processes considered for each configuration are indicated. Salinity is considered in all model configurations. Note that one configuration with no sediments in the system is tested as well, to establish the equilibrium salinity penetration without the influence of sediments.

model configuration	type of bed model	sediment in the model	sediment at bed initially	erosion and deposition
1	standard D3D	no	no	no
2	standard D3D	yes	no	no
3	standard D3D	yes	no	yes
4	standard D3D	yes	yes	yes
5	buffer layer model D3D	yes	no	yes

Hyper-turbid conditions have not developed under the studied set of parameters yet. However, a number of important conclusions can be drawn from the current work. General conclusions form the study of model configurations:

- Erosion and deposition, in combination with tidal asymmetry, are responsible for the transport of sediments into the estuary. This is important, since without suspended sediments distributed throughout the whole system, hyper turbid conditions cannot develop under any circumstance.

- The presence of internal asymmetry (vertical stratification in sediment concentration) contributed to further increase the import of sediments into the system via two mechanisms: a. the combination of sediment mixing during high energetic conditions (and stratification during low energetic conditions) and tidal asymmetry. b. The decrease in eddy viscosity that a fluid mud layer produces and the associated tidal amplification.

- With erosion and deposition allowed in the model, and with the effect of internal asymmetry, sediment keeps accumulating in the system after 66 months.

- The initial amount of sediment in the system does not affect the equilibrium suspended sediment concentration in the water column, which is determined by the balance between erosion and deposition (given a constant sediment supply).

Within each of the studied model configurations, the sensitive of a selection of sediment and hydrodynamic parameters in the import of sediments into the river