Residual sand and mud transport in the Scheldt estuary derived from the sediment balance

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Introduction: Sediment transport is important for several estuarine functions. The morphology determines both the tidal propagation in the estuary and the port accessibility [1]. Suspended sediment influences the light penetration in the water column and therefore it is crucial for ecology [2]. The residual sediment transport is crucial for the future evolution of the estuary. To visualise this residual sediment transport on a longer time scale (years), a sediment balance was calculated for the Flemish part of the Scheldt-estuary.

Methods: The sediment balance is calculated starting from the principle of conservation of mass applied to a simplified schematization (boxes) of the system. The boxes were defined as 5 to 10 km-long segments (Figure 1), which were previously defined within the OMES-project. Within a certain box, changes in sediment volume are explained by (1) an up-estuarine flux of sediment, (2) an down-estuarine flux of sediment and (3) external factors creating a flux of sediment (e.g. sand mining and dredging works).

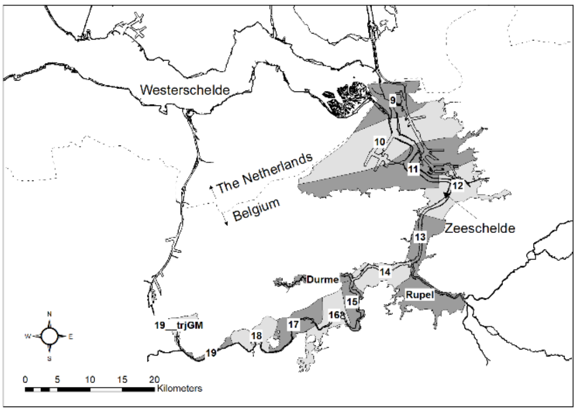

Fig. 1: The Schelde-estuary and the schematisation in *OMES* boxes

The changes in volumes are derived from topo-bathymetries for different moments. The volumes are converted to mass fluxes for sand and mud separately by sand-mud bottom characteristics based on 100’s of individual bottom samples, taken over different habitats. Based on Koltermann et al. [3] the porosity was derived depending on the sand-mud-percentage within the specific habitat.

At the most up-estuarine boundaries, the fluvial sediment influx is derived from measurements upstream the estuary and its tributaries.
The anthropogenic fluxes are derived from registrations. Starting from these known parameters the down-estuarine sediment flux is derived, which is also the up-estuarine flux for the neighboring box.

Results: The sand balance for the period 2016-2019 (Figure 2) shows up-estuarine transport of sand over the entire estuary. This can be explained by the importance of higher flow velocities in the sand transport, where the sand transport relates to velocity to the power 3 to 5 (eg. Engelund-Hansen formula). The Schelde-estuary is characterised by higher flood velocities, leading to a flood dominance in sand transport.

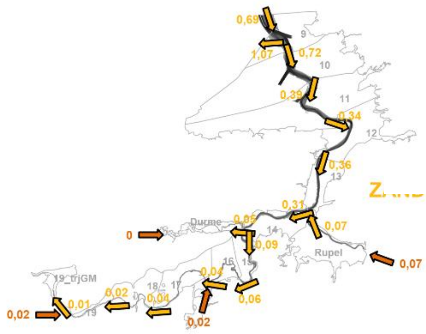

Fig. 2: Mean annual residual sand transport 2016-2019 (Million Ton Dry Material)

The mud transport has a different pattern, with a down-estuarine transport over most of the estuary. Only at the most downstream location, mud transport is up-estuarine. For mud transport the classic advection-diffusion equation is valid. The tidal asymmetry (increase of ebb period up-estuary) and the increasing importance of fresh water discharge up-estuary, will result in a more ebb-dominant mud transport.

References: ; [1]Smolders et at. (2015) *Nat. Hazards Earth Syst. Sci.* 15 (7): 1659–1675; [2]Meire et al. (2005) *Hydrobiologia* 540 (1–3): 1–11; [3] Koltermann et al. (1995) *Water Resour. Res.*, 31(12), 3283– 3297.