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Residual sediment transport in a stratified estuarine channel

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After major storm surge protection works in the Rhine-Meuse Delta, referred to as the Delta Works (Vellinga et al., 2014), the New Waterway has become the only remaining open channel connecting the estuary to the North Sea. Like in many harbour areas, continuous deepening of this channel for navigation purposes has led to strong stratification and often salt wedge conditions, which likely has a strong impact on the marine sediment import. The sediment balance for various fractions is highly uncertain (Cox et al., 2021). Based on field measurements and sediment transport modelling, we aim to unravel the mechanisms controlling residual sediment fluxes in highly stratified estuarine channels, by focusing on the New Waterway.

A measurement campaign was set up consisting of two 13-hour surveys, one during spring tide and one during neap tide. A measurement frame was equipped with a LISST-100x, a Seapoint turbidity meter and a CTD probe. Suspended sediment samples are collected every hour at three depths, next to water temperature, salinity and turbidity. The flow was monitored continuously based on a vessel-mounted ADCP transects across and along the channel .

The ADCP-measurements show a clear distinction in flow magnitude and direction between the upper fresh water layer and lower saline layer, confirming the high degree of stratification especially during neap tide. After low water slack, most suspended sediment is found in the lower half of the water column. Suspended sediment concentrations (SSCs) increase during the flood acceleration phase, suggesting local resuspension during this phase of the tide. When reaching high water slack, SSCs decrease with flow velocity. At high water slack, the ADCP-backscatter profiles indicate settling of the suspended sediment on top of the pycnocline. During the ebb phase, SSCs increase again, and the water column is better mixed compared to the flood phase. Preliminary results of the grain size analysis indicate coarsening of the suspended sediment at the end of the flood acceleration and ebb acceleration phases. Ongoing analysis of these data and numerical modelling of SSC will provide more insight in the suspended sediment transport processes under various degrees of stratification.

Cox, J. R., Huismans, Y., Knaake, S. M., Leuven, J. R. F. W., Vellinga, N. E., van der Vegt, M., et al. (2021). Anthropogenic effects on the contemporary sediment budget of the lower Rhine-Meuse Delta channel network. Earth's Future, 9, e2020EF001869. https://doi.org/10.1029/2020EF001869

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