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Estimating ship-induced sediment transport in confined waters

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The maintenance of waterways is a challenging task for federal authorities. An expensive subtask is dredging and disposing of accumulated sediments. Dredging volumes are often estimated based on experience while the underlying physical transport processes causing sedimentations are not fully explored yet. For instance, in confined waterways moving ships have an influence on the turbidity by resuspending sediments which can then be transported by prevailing currents. Therefore, the German Federal Waterways Engineering and Research Institute (BAW) conducted an eight-day field campaign using a network of three probes which recorded parameters like turbidity, pressure, and flow velocities in the Kiel Canal (Schleswig-Holstein, Germany). The advantages of this canal as test site are the laboratory-like conditions with almost no natural flow and no influence of tides. Data assimilation and analysis of the field campaign have been performed at the Research Institute for Water and Environment at the University of Siegen as part of a research cooperation with the BAW to estimate the ship-induced proportion of the totally transported sediment volume in the Kiel Canal.

Therefore the three high-frequency turbidity records from the canal bed were used to model the turbidity distribution in the canal cross-section. Linking the turbidity distributions with the measured flow velocities yields an estimation of the totally transported sediment volume during the field campaign. In a second step smoothing the turbidity and flow velocity time series and recalculating the estimation removes all ship influences from the transported volumes so that the difference in both volumes describes the ship-induced proportion of the totally transported sediment volume.

As a result, a proportion of about 10% of the entirely transported sediments can be attributed to ship-induced resuspension. In reverse, the majority of the sediment transport originates from a slow but steady drainage flow in the Kiel Canal. The estimated results are plausible and in an expected dimension with regard to the annual dredging rates of the last years. The developed methods are currently applied to a new dataset from a second field campaign in the Elbe River. This system is, in contrast to the Kiel Canal, dominated by tidal dynamics. Preliminary results with a focus on the main differences between both campaigns will also be presented.