Use of rare earth elements and optical cable to quantify the sedimentation from different sediment sources in Port of Rotterdam

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Introduction: The pilot undertaken for the EU INTERREG NWE project SURICATES reallocated roughly 500.000 m3 of harbor sediment within the New Water Way (NWW). By placing this sediment on a strategic spot (on the doorstep of a constructed wetland) and by using sediment from a different source as compared to the present sediment, a sedimentation balance could be constructed.

Methods: To quantify the sedimentation an optical cable with a Distributed Temperature Sensing (DTS) unit was used. By using a vertical pole with a heating wire the thermal capacity of the matrix can be determined. This can be used to determine the sediment density.

Two passive (not heated) horizontal optical cables were used to follow the sedimentation pattern in the NWW over time. For the passive cable the water temperature change due to the tide were used.

To quantify the source of the sediment rare earth element characterization was carried out. Rhine sediments are enriched with Lanthanum while marine sediment, which is normally present in this part of the harbor follows the 'normal' distribution of rare earth elements. The reallocation source area harbor sediments have an enrichment in Lanthanum.

Results: It was expected that during a tide there would be a variation in sedimentation rate on the river bank (a constructed wetland) next to the reallocation are. This variation was not observed.

The passive optical cables showed minimal (but detectable) variation in the cross sections of the pilot area during the reallocation period.

Tracing the rare earth element Lanthanum shows promising results for following shifts in sedimentation patterns on a system wide scale. The study area (20 km up- and downstream of the NWW) could be quantified regarding the amount of Rhine sediment, and was an impacted in composition due to the reallocation. Figure 1 shows the Lanthanum sediment enrichment results.

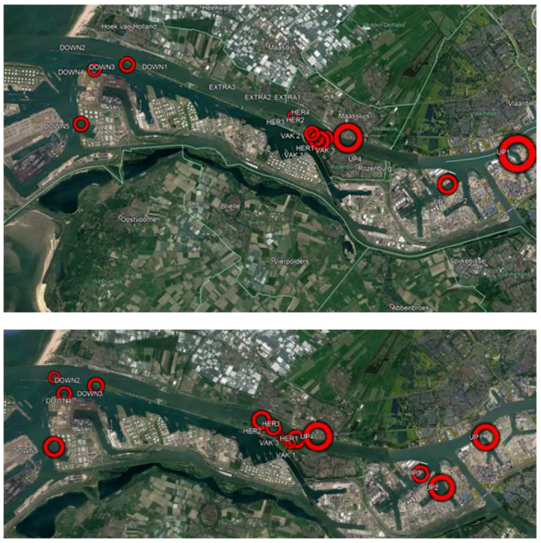

Fig. 1: Top, initial T_0 Lanthanum enrichment in the NWW (as compared to marine sediment). Bottom the NWW Lanthanum enrichment after 9 months compared to T_0.

Discussion: Based on both the active and passive optical cable results the reallocation of 500.000 m^3 over a 6 months period did not lead to extra sedimentation in the target area.

The rare earth analyses showed that only a fraction of the reallocated sediment settles in the harbor area. The location of the extra sedimentation is in accordance with the model predictions (not shown). The impact is limited regarding the overall system sediment balance. As an example, the most impacted location has an increase of 7.6% in the Rhine sediment fraction. On average the increase in the sedimentation of Rhine sediment in the studied area due to the reallocation is 0.2%, while on the river bank next to the reallocation site (the constructed wetland) there is a decrease of 1.3% in the harbor sediment fraction. The net sedimentation effect due to reallocation is +/- zero.

Reallocation of dredged sediment at this spot in the NWW (10 km upriver from the North Sea) during the tidal window of one hour after turnaround of the tide does not impact the sediment balance of the harbor.

References: INTERREG project SURICATES.