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Monitoring sediment coverage from Distributed Temperature Sensing measurements in the Port of Rotterdam, the Netherlands

Manos Pefkos¹, Pieter Doornenbal¹, Arjan Wijdeveld², Ebi Meshkati Shahmirzadi³, and Pauline Kruiver¹

¹Deltares, Applied Geology and Geophysics, Delft, Netherlands (manos.pefkos@deltares.nl)

²Deltares, Experimental Facility Support, Delft, Netherlands

³Deltares, Ecosystems and Sediment Dynamics, Delft, Netherlands

Distributed Temperature Sensing (DTS) measurements were conducted in the Port of Rotterdam as part of the INTERREG NWE SURICATES project. In the Port of Rotterdam a program is running to retain sediments in the harbor for river bank protection, and to lower the costs of transferring sediment from the port to the offshore dump locations. The aim of the DTS monitoring is to find spatial patterns in sediment deposition and erosion and thus determining the sediment balance before, during and after re-allocation. Fibre optic cables were installed in two layouts. Two fibre optic cables of lengths 1.2km and 750m were laid out flat parallel and perpendicular to the shore and they passively recorded temperature. Another cable was wrapped helically on a vertical pole condensing 150 m of length into 0.77m, increasing the spatial resolution. This cable was used for passive measurements and active heating experiments. The acquired data span the period from May to September 2019.

The active heating experiments showed that the water-sediment interface along the pole can be tracked from the difference in response between the time when the heating cable is switched on and off. The pole's passive temperature analysis indicates that signals from the water phase exhibit high variability with time, whereas those from the sediment phase have low variability. Frequency domain analysis of the water phase shows clear peaks in the Fourier Amplitude Spectrum (FAS) at one day and half-day cycles, with the half-day cycle peak having the highest magnitude. The same peaks are present in the sediment phase's FAS, but their magnitudes are about an order of magnitude lower.

The Fourier amplitude at frequencies corresponding to half-day periods was used for classification of the phases along the pole. The interface between water and sediment is defined as the maximum in the derivative of the Fourier amplitude with height. The interface's height and thus the occurrence of erosion or deposition was tracked over time. The analysis shows that the sediment interface varied around 5cm over a period of 2.5 months between two dredging actions.

Representative signals from the Fourier amplitude at half-day cycles from the pole were used to derive sediment coverage over the flat passive cables. However, further research is required to establish the minimum horizontal distance over which coverage can be established.

We conclude that, by comparing the spectral properties of the temperature signal of water and sediment phases, sediment coverage over fibre optic cables can be monitored with DTS measurements. The finest time and spatial resolution over which this coverage can be found remains to be decided and can be the subject of future work.