Impact of marine traffic and dredging activities on resuspension and release of contaminants from sediments in the port of Antwerp

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Introduction: Worldwide, aquatic ecosystems are featured with serious contamination problems and hotspots have in particular been identified in densely populated and industrialized areas. The individual compartments of aquatic systems are in a continuous exchange with each other and contaminants stored in sediments can have the potential to negatively affect surrounding water quality by acting as secondary source of contamination [1]. Next to this, bioavailable fractions of sediment bound contaminants can have widespread effects on biota [2]. Various abiotic factors such as the redox potential, water hardness, pH, salinity, the amount of organic material or temperature [3] can be responsible for contaminant speciation, bioavailability and toxicity. Here, physical disturbances and sediment oxygenation through shipping and dredging activities can play an important role in causing resuspension and through this in the release of large amounts of (bioavailable) conta-minants associated with the sediment [4,5]. Suchlike resuspension events have also been observed in the port of Antwerp, which is Europe's most central sea port and highly frequented by ships with a large draught (up to 18metres) and dredged on a regularly basis to maintain the required navigation depth. While the general status of the water and sediment quality within the harbour docks is well documented, the impact of these shipping and dredging actions on the resuspension and diffusion of its sediments and related contaminants is rather unknown. In the course of the EcoDocks project, extensive field measurements before, during and after different shipping and dredging actions have been performed to evaluate its impact on the resuspension of sediments and related contaminants to increase the general knowledge about the spatial and temporal variation in sediment and contaminant concentrations and to identify indicating parameters for contaminant flux behaviour (Hanne Hetjens, University of Antwerp).

Methods: During nine large measuring campaigns (February to April, 2016), different shipping activities (docking, departure, turning and pass through) and dredging activities (Trailing Suction Hopper Dredger (TSHD; Bed Levelling Tug (BLT) have been followed within the right harbour bank. Changes in concentrations of suspended particulate matter (SPM) were measured by the use of specialized measuring instruments (Acoustic Doppler Current Profiler (ADCP) in combination with a Silt Profiler (SP) and OBS-3A for velocity, backscatter, salinity, conductivity, temperature, depth and turbidity measurements. In addition, water samples were taken for contaminant analysis (PAHs, PCBs, TBT, mineral oils and metals).

Results: For all maneuvers increases in SPM concentrations were measured, with TSHD actions having the highest effect, followed by BLT dredging and ships docking, turning, departure and passing maneuvers. No general resuspension patterns, relatable to known factors such as vessel depth, length or type of manoeuvre, could be found. Much more factors such as the use of tug boats or the own propeller as well as the strength and direction of the wind seemed to be more determining. None of the taken water samples showed detectable PCB concentrations and for PAHs and mineral oil, the effects of increasing SPM concentrations were low. Measured TBT and metal concentrations in the water layer exceeded formulated quality standards. A comparison with the sediment resuspension data revealed no correlations. While no risk indicator was found for PHAs, PCBs and mineral oil, the total metal concentrations showed strong correlations with the SPM concentrations and the dissolved TBT fractions with the calculated logKd.

Discussion: Both, various shipping and dredging actions are responsible for high quantities of sediment resuspension, however, with low to no detectable impact on changes in contaminant concentrations in the water layer. The impact of the sediment under resuspension on the surrounding water quality is therefore lower than expected. Nevertheless, various dissolved metal and TBT background concentrations in the water layer were experienced to be high enough to form a (high) toxicological risk for the environment and should therefore be further monitored.

References: [1] Zhu et al. (2016) *Environ. Sci. Pollut. Res.* 23, 5516; [2] Liu et al. (2016) *Chemosphere* 144, 2329–2335; [3] Luoma and Rainbow (2011) *Cambridge Univ. Press*; [4] Fathollahzadeh et al., (2015) *Chemosphere* 119, 445–451; [5] Rapaglia et al. (2011) *J. Mar. Syst*. 85, 45–56

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