Study on wave systems and their impact on the seabed and water column turbidity in the Belgian coastal zone

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Suspended particulate matter (SPM) concentration is one of the key parameters to describe the environmental status, and to evaluate and understand the impact of human activities on the water column and seabed in both nearshore and offshore areas. In order to do so, long-term measurements are needed in order to resolve all natural variations in SPM concentration. Processes affecting SPM concentration are turbulence caused by tides under both neap and spring tide cycles, and by meteorological events. Other, more long-term fluctuations are related to seasons. SPM concentration has been measured since 2005 at the MOW1 site and the Blankenberge site, situated west of Zeebrugge in the high-turbidity zone off the Belgian-Dutch coast. The measurements have been carried out using a benthic tripod that allowed measuring during all meteorological conditions, including storms.

The impact of extreme weather conditions (e.g. storms) on sediment resuspension and SPM concentration has been investigated using meteorological and wave data from IVA MDK (afdeling Kust - Meetnet Vlaamse Banken). SPM concentration data from MOW1 and Blankenberge were estimated using the backscatter data from a 3MHz acoustic Doppler profiling current meter.

A semi-automatic detection algorithm for identifying extreme events in SPM was developed to handle the large amount (~4 years) of SPM concentration data. These events were caused by following specific extreme weather conditions: 1) NW storms with high swell activity, 2) SW storms and 3) strong NE winds. In total 41 events of extreme SPM concentration were detected of which 19 were caused by a NW storm, 14 by SW storm conditions and 6 by strong eastern winds. Two events could not be classified.

NW storms accompanied by swell waves (i.e. waves with longer-than-average period) generate bottom shear stresses up to 30 Pa, causing strong resuspension and erosion of fluffy bed material and of the bed itself. This occasionally leads to the formation of high concentration mud suspensions (HCMS). Upward mixing of SPM in the higher water column is hindered due to the high SPM concentrations causing a decrease in turbulent energy. In contrast, SW storms are characterized by a lower erosion capacity and a better upward vertical mixing of SPM. In general, only NW storms can induce resuspension and erosion in the navigation channels. NE winds cause increases in SPM concentration by the advection of sediment out of the Westerschelde mouth. Additionally, the interaction of different wave systems, together with water depth and sediment type will play an important role in understanding the variation in impact of different extreme weather conditions.

Keywords
Suspended particulate matter; storm impact; Southern North Sea; mixing; high concentrated mud suspensions.