

# Factors influencing top sediment layer and SPM concentration in the Zeebrugge harbor

Dujardin Arvid<sup>1</sup>, Joris Vanlede<sup>2</sup>, Thomas Van Hoestenbergh<sup>1</sup>, Luc Van Poucke<sup>1</sup>, Michael Fettweis<sup>3</sup>, Claudio Cardoso<sup>1</sup>, Carlos Velez<sup>1</sup>, Renaat De Sutter<sup>1</sup> and Chantal Martens<sup>4</sup>

<sup>1</sup> Antea Group, Buchtenstraat 9, B-9051 Gent, Belgium  
E-mail: [arvid.dujardin@anteagroup.com](mailto:arvid.dujardin@anteagroup.com)

<sup>2</sup> Flanders Hydraulics Research, Department of Mobility and Public Works, Flemish Government, Berchemlei 115, B-2140 Antwerp, Belgium

<sup>3</sup> Operational Directorate Natural Environment, Royal Belgian Institute of Natural Sciences, Gulledele 100, B-1200 Brussels, Belgium

<sup>4</sup> Maritime Access Division, Department of Mobility and Public Works, Flemish Government, Tavernierkaai 3, B-2000 Antwerp, Belgium

The port of Zeebrugge (Belgium) suffers from significant siltation. To safeguard navigation, on average 5 million tons (dry matter) is yearly dredged inside the harbor (Dujardin *et al.*, in progress) and an additional 1.6 million tons (dry matter) in the access channel Pas van het Zand (Lauwaert *et al.*, 2006 & 2008), and disposed on authorized disposal sites in the Belgian part of the North Sea. Numerical model results indicate that a significant part of the disposed sediments recirculates back from the current disposal sites to the dredging areas (Van den Eynde and Fettweis, 2014). A field study, accompanied by an extensive monitoring campaign, was set up in 2013-2014 to verify whether using an alternative disposal site is influencing the SPM concentration and the top sediment layer in the harbor. In addition to the monitoring campaign and in order to better assess the results of the field study, the baseline system behavior was also characterized over a longer period (1999-2012).

The mechanisms causing the sediment from the North Sea to enter the harbor have been intensively studied the last decade (Dujardin *et al.*, 2009; Vanlede and Dujardin, 2014). The sediment dynamics inside of the harbor, however, are still largely unknown. The present study aims to quantify the influence of internal and external factors on the sediment dynamics within Zeebrugge harbor, based on both the 2013-2014 monitoring campaign and the longer period datasets. Possible factors external to the harbor are tide, wind, currents, wave climate, salinity and SPM concentration. The factors internal to the harbor are navigation, dredging operations and fresh water discharge.

For the 2013-2014 campaign, measurements inside and outside the port of Zeebrugge of various oceanographic and sediment parameters (SPM concentration, current velocity, waves, salinity, temperature, tides, wind, bathymetry, density of mud layers) were conducted during the whole duration of the experiment. The measurements outside the port are presented in Fettweis *et al.* (this volume). The monitoring inside the port was carried out at 4 locations. At each location, time series of currents, salinity, temperature, water elevation and SPM concentration were collected near the surface and near the bed. Measurements show for all locations that the maximum SPM concentration reaches more than 4g/l near the bed and up to 2g/l at the surface.

For the characterization of the baseline system behavior, a long-term dataset (1999-2012) is available of the height of the 210kHz and 33kHz reflector, fresh water inflow in the harbor, wind, wave, and tidal data, surface SPM data derived from satellite images (GRIMAS dataset) and dredging quantities. Within this dataset, bathymetric measurements were less frequent than during the 2013-2014 field study, except for the summer of 2012 (Dujardin *et al.*, 2014).

Correlations between different parameters are analyzed, both for the shorter (one year) and longer (13 year) period. Statistical relations were established based on the long-term dataset (Dujardin *et al.*, in progress) and the results from the 2013-2014 study were compared with the findings for the 1999-2012 period. In the harbor, local currents, tidal amplitude and SPM concentrations are significantly correlated. Daily variations in SPM concentrations and bathymetry (210kHz reflector level) are related to tides, storms, seasonal changes, ship movements and dredging operations.

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