The potential of multibeam sonars as 3D turbidity and SPM monitoring tool in the North Sea

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Monitoring turbid areas in the Belgian Part of the North Sea (BPNS) is important as high turbidity can have a detrimental impact on water quality and marine life (Capuzzo *et al.*, 2018). Increasing human activities like the construction of offshore windmill parks and dredging activities may significantly increase suspended particulate matter (SPM) variability. Improving our understanding of both natural and human-induced SPM variability is therefore essential for sustainable coastal management.

Remote sensing of ocean color has been used successfully for decades to monitor turbidity and SPM in the North Sea (Dogliotti *et al.*, 2015), but is restricted to the surface layer of the water column. Within the water column, SPM and turbidity are currently measured with optical and acoustic sensors that are attached to stationary (1D; Baeye and Fettweis 2015) or moving (2D; Vanlede *et al.* 2019) platforms. However, coastal areas are dynamic environments where SPM patterns can exhibit large spatiotemporal fluctuations (Fettweis *et al.*, 2014). Hence, there is a clear urgency to monitor these SPM changes in 3D with a fast and cost-effective approach.

A possible solution lies in multibeam technology, which is based on the emission and detection of sound pulses in a swath. Multibeam systems have originally been developed for measuring seafloor bathymetry, but thanks to advances in storage capacity and processing power, multibeam sonars can nowadays also deliver a 3D dataset of acoustic backscatter intensities in the water column. Multibeam water column data has been embraced by a myriad of applications (Colbo *et al.*, 2014), including fisheries, gas seepage and shipwreck research. However, only a handful of studies have used multibeam water column data to quantify suspended sediments in the water column. Moreover, most of these studies were conducted in a controlled environment (Simmons *et al.*, 2017) or a semi-experimental setup (Fromant *et al.*, 2021). Studies that focus on deriving quantitative turbidity and SPM information from multibeam data in natural uncontrolled environments are scarce.

During 2020-2021, five campaigns were conducted with the RV Simon Stevin in the Kwinte and Westdiep areas. Large datasets (several tens of GB) of 3D multibeam water column and in-situ optical sensor data were collected simultaneously. Their empirical relationship was investigated with linear regression modelling using the high performance compute capacity of the Flemish Supercomputer Center.

The resulting relationship between acoustic backscatter intensity and volume concentration (of the LISST-200X) was used to convert the 3D acoustic backscatter intensity volumes into a 3D grid that displays the mass concentration of suspended particulate matter. These 3D SPM volumes for each campaign provide for the first time a 3D view on SPM variability in the BPNS. Hence, this study has clearly demonstrated the potential of multibeam sonars as future turbidity and SPM monitoring tool, for both scientific and industrial purposes.

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Keywords
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