Quantifying sediment plumes induced by human activities by using MBES and SBES water column data combined with in situ measurement and water sampling: feasible?

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The Belgian part of the North Sea is an area of dense economic activities generating various impacts on the marine environment. Most of these activities are closely monitored, but important questions remain regarding the direct and indirect impact from diversely generated sediment plumes. To the point, human-induced Suspended Particle Matter (SPM) plumes could, including transport and resedimentation, notably modify the habitats within a certain radius around their centre of creation. A clear example are the gravel areas, hosting high biodiversity, that border the sandbanks where sand extraction takes place.

Recently, attempts to evaluate the volume of SPM generated by human activity in real-time by direct field observation, resulted in a series of simultaneous acoustic water column measurements with a Kongsberg EM2040 dual RX multibeam echosounder (MBES) and a Simrad EK80 calibrated single beam echosounder (SBES) onboard the RV Simon Stevin, while tracking different sand dredging vessels and beam trawlers during their activity. Qualitatively, the dynamic observation of polar and longitudinal echograms derived from the backscatter values (Sv in dB/m³), normalized for the volume of water involved, revealed vortices of highly variable Sv levels. These effects can potentially be attributed to SPM plumes from dredging and trawling activities. The development of specific echo-integration algorithms makes it possible to quantify the Sv level within different slant ranges and angular intervals of the water column, as a function of time. Although a substantial part of the swirls of Sv in the upper part of the water column is linked to the propulsion of the research vessel itself, Sv level time series acquired near the seabed made it possible to distinguish between stable Sv levels, characterizing water masses that are not affected by human activity, and intense and fluctuating Sv level phases, linked to the presence of sediment plumes .

Based on in situ SPM concentration measurements from water filtrations and grain size measurements acquired synchronously with the acoustic data, continuous SPM concentrations were derived from acoustic measurements, using a scattering model. Additionally, tidal cycle stationary measurements were conducted at a coastal site where highly turbid and changing waters prevail. On this location, Kongsberg EM2040 dual RX MBES and Simrad EK80 calibrated SBES water column data measurements were combined with in situ measurements by an optical turbidity sensor (Campbel Scientific OBS3 +) and laser scattering and transmissometer (LISST 100C of Sequoia Scientific Inc.). Water samples using Niskin bottles were harvested at regular intervals. However, the spatial distance between the fixed sensors and the in situ measuring and sampling, can reduce the consistency between them and explain the relatively weak correlation that was observed on this location between the SPM concentration and the EM2040D Sv levels.

The sediment plumes generated by human activities at sea are difficult to grasp due to their diffuse nature, implying strong spatial and temporal variability. The results obtained within this preliminary study demonstrate that quantification by scientific measurements at sea should be feasible but highly challenging, requiring suitable logistics, the implementation of dedicated calibrated acoustic devices synchronized with in situ SPM measurements and water sampling. Real-time integration of hydrodynamic data combined with the position of the research vessel and with that of the vessel generating the sediment plume must be considered as well.