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Impact of offshore dredging activities and wind farms installation on the sediment transport: scenarios definition and implementation using the coupled Ocean-Wave-Sediment Transport (COAWST) modelling system

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In the recent decades, the Southern Bight of the North Sea (SBNS) and, in particular, the Belgian Coastal Zone (BCZ) have been affected by human activities (e.g. aggregate extraction, dumping and installation of offshore wind farms), that have affected seafloor composition and, in particular, sediment grain size distribution with potential consequences for biodiversity and biogeochemical cycles that we hardly know. Assessing the impact of offshore wind farms and dredging at the scale of the ecosystem is a necessary requirement for the implementation of a sustainable blue growth strategy. It requires the development of sound tools capable to scale up the local impact inferred from observations to those large scale consequences in which managers are interested.

With that aim we develop a hydrodynamical model of the SBNS with a focus on the BCZ, where multiple wind farms (C-Power, Belwind, Northwind and Nobelwind) are currently in place and future deployments are foreseen in the next years. We implement the Regional Ocean Modeling System (ROMS) model that is a part of the Coupled Ocean-Atmosphere-Wave-Sediment Transport (COAWST) model (Warner, 2010) to solve the hydrodynamics of the SBNS with a focus on the BCZ, including tides and waves from SWAN. The SBNS model with a resolution of 5 km is forced at its open boundaries by conditions coming from the Copernicus Marine Environment Monitoring Service (CMEMS, http://marine.copernicus.eu/), WAVEWATCH III wave products and tidal constituents from TPXO. The BCZ is covered by a high resolution model (i.e. 1 km), two-way nested into the SBNS model. Model results and observations are compared in terms of gridded fields (class 1 metric); time series assessments at specific locations (class 2 metric) and derived quantities (class 3 metric). The high resolution model has been found to have better performances in terms of simulation of Scheldt plume, residual current intensity and pattern, tidal dynamics and transport. The hydrodynamical model is then coupled with the sediment model available in COAWST. The dynamics of consolidated and unconsolidated sediment is represented by several size classes each of them associated to a specific parametrization derived from the literature or field studies.

Results are compared with maps of sediment grain size distribution and hydrodynamical processes, that are key for sediment transport, are analyzed. Then, scenarios of modifications of sediment composition due to human activities (e.g. extractions) are investigated.

This work is performed in the frame of the BELSPO FaCE-It project (Functional biodiversity in a Changing sedimentary Environment: Implications for biogeochemistry and food webs in a managerial setting), which is targeted towards understanding the impact due to sediment fining and hardening on the functioning of benthic ecosystem on the large scales for the implementation of the Marine Strategy Framework Directive.

References:
Warner, John C., et al. "Development of a coupled ocean–atmosphere–wave–sediment transport (COAWST) modeling system." Ocean modelling 35.3 (2010): 230-244.