Working together on innovative monitoring strategies: adapting to nature, huge demands and grand challenges

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Socio-economic demands for marine aggregate resources have increased at an unprecedented pace. For the Atlantic region, hundreds of millions m^3 of offshore sand and gravel have been extracted for coastal maintenance, harbour extensions and onshore industrial use. Still, we are facing grand challenges, for which aggregate demands will be even higher. First, increasing volumes of nourishment sand are needed as accelerating sea-level rise will leave our coastlines ever more vulnerable. Secondly, vast quantities of sand and gravel will have to be extracted to realize the large infrastructural works that are the key components of many visions on coastal zone and offshore development. Meanwhile, nature protection is increasing as well, and appropriate assessments are needed of the environmental impacts.

The far offshore Hinder Banks are targeted for exploitation of huge quantities of sand, mainly for coastal defence works. Here, up to to 2.9 million m^3 can be taken over 3 months, with a maximum of 35 million m^3 over a period of 10 years. Large vessels can be used extracting 12500m^3 per run. Present-day yearly extraction levels recently surpassed 3 million m^3, the majority of which was extracted with vessels of 1500m^3. South of the Hinder Banks concession, a Habitat Directive area is present, hosting ecologically valuable gravel beds. For these, it is critical to assess the effect of multiple and frequent depositions from dredging-induced sediment plumes.

How will nature react?
We anticipated with a monitoring strategy, tailored for assessing the importance and extent of perturbations that are created by the extraction activities. Our monitoring design is focussed on hydrodynamics and sediment transport with feedback loops between both modelling and field studies. Main targets are assessing changes in seafloor integrity and hydrographic conditions, two key descriptors of marine environmental status within Europe's Marine Strategy Framework Directive.

State-of-the-art instrumentation (from RV Belgica) is used, to measure the 3D current structure, turbidity, depth, backscatter and particle size of the material in the water column, both in-situ and whilst sailing transects over the sandbanks. In the Habitat Directive Area, gravel bed integrity (i.e., epifauna; sand/gravel ratio; patchiness) is measured as well. Most innovatively, an autonomous underwater vehicle was deployed (Wave Glider, Liquid Robotics), resulting in 24 days of current and turbidity data.

From a first data-model integration, and analyses against hydro-meteorological databases, main results show: (1) high spatial and temporal variability of turbidity, unexpected in the so-called 'clear' waters of the Hinder Banks; (2) important resuspension by waves, regardless the area being considered as 'deep'; (3) spreading and deposition of sediment plumes; and (4) competitiveness of ebb and flood, meaning that the potential for sediment deposition to the south is high. Plume dispersion mechanisms and pathways are now estimated and modelled.

Data will be integrated with results from the morphological and biological monitoring, respectively carried out by the Continental Shelf Service of FPS Economy and the Institute for Agricultural and Fisheries Research. Together, temporal and spatial patterns, scale and processes can be resolved and interlinked with pressures and system vulnerability.