Sand, sand, sand, where does it all end?

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Our society is hungry for sand, and its steady supply is needed increasingly to secure coastal safety in the low-lying countries. Sparked by nature's solutions on coping with water, more and more alternative ways to shoreline protection are on the rise, relying typically on huge volumes of marine sands. To what extent we can keep on increasing such marine sand usage without affecting adversely the environment remains an open question.

The offshore extraction of marine sands causes sediment reworking at accelerated rates. But sand extraction is not the only actor disturbing the seafloor. We dredge and relocate, we fish, we plough, we build and cultivate. Meanwhile, we assess impacts, though hitherto mostly for single cases and considering one period of interest. The combined disturbance we exert on the seafloor remains mostly in the cumulative impact hypotheses sphere.

Hitherto unprecedented, we attempted a cumulative dispersal modelling of sediment particles released by the main seafloor disturbing activities (e.g., fisheries, extraction, dredging and disposal) over the entire Belgian part of the North Sea and for a full year. An integrated database was set-up comprising spatial data from electronic monitoring systems (location and time), technical information from vessels (size and gear), but also estimated particle amounts in kg. Three-dimensional hydrodynamic models (https://odnature.naturalsciences.be/coherens) were used to force the Lagrangian dispersion model OSERIT (Dulière et al., 2013) that has been further developed to simulate the transport and fate of sediment particles. Processes that are accounted for are: (1) advection of particles under the complex influence of the met-ocean conditions (3D currents, waves and tides); (2) turbulent mixing; (3) sedimentation; and (4) resuspension. Running more than hundred thousand of numerical simulations, the release of silt and fine sand particles per disturbing event in the year 2019 was tracked for 14 days. For comparative analyses, the mass of sediment released by the various activities was accounted for. For all activities, spatially-explicit deposition maps were created at a resolution of 1 x 1 km with a minimum time resolution of 1 day of activity. These can be further aggregated into other time intervals such as monthly, seasonally, or yearly. In a next step, these are then evaluated against the presence of sensitive receptors (e.g., gravel beds) of which distribution maps were recently renewed (Van Lancker et al., 2023). Per region of interest the main influencing human activities can be backtraced.

Future applications relate to identification of potential environmental effects of seafloor disturbing projects. It is meant to support environmental risk assessment and decision making, e.g., evaluating technical choices, proposing appropriate mitigation, choosing best restoration sites, guiding and optimizing management and monitoring measures.

Research is conducted in the framework of the projects VLAIO SUSANA (SUstainable use of Sand in NAture-based solutions) and ZAGRI, a federal Belgian program for the continuous monitoring of sand and gravel extraction, paid from private revenues. The developments align with RBINS' Research Strategy on Science for a Sustainable Marine Management and with the roadmap of RBINS Marine Forecasting Centre to deliver an operational service on impact forecasting of human activities, which is a shared 2030 vision within EuroGOOS.

References

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Keywords

Lagrangian modelling; particle transport; cumulative dispersion modelling; far-field impact; seafloor integrity; decision support