



Effect chain indicating the links between ecosystem components, the external pressures and human activities acting on them, and the modelling tools available at Deltares to investigate the effects on the various components.

ECOLOGICAL MODELLING FOR THE ENVIRONMENTAL IMPACT ASSESSMENT OF SAND EXTRACTION IN THE NORTH SEA

Both the Dutch government (represented by Rijkswaterstaat) and a consortium of commercial dredgers (the LaMER Foundation) are applying for permits to extract sand in the Dutch coastal zone between 2018 and 2027. These activities could lead to an increase in the fine sediment concentration in the water and therefore reduce light penetration.

Algal productivity could be reduced as a result and, in turn, there may be a negative impact on shellfish and other important ecosystem components that feed on the algae. Although there will be no sand extraction in the Wadden Sea, there is a risk of indirect effects on this ecosystem if significant amounts of suspended sediment are transported into it. An Environmental Impact Assessment (EIA) is therefore required for these permits.

The question of how sand extraction in the coast will affect the ecosystems of the North Sea and the Wadden Sea is very complex: it cannot be answered adequately on the basis of expert judgement and certainly not on the basis of standard tools and models. Deltares (together with Wageningen Marine Research as subcontractor) was therefore

asked to supply model simulations to support the EIA. The model results were then used by the SWECO to conduct the actual EIA.

Deltares developed hydrodynamic, fine sediment dynamics and ecological models. The first two were very similar to the models used for the previous EIA (for the period 2011-2017). The main difference in the fine sediment model was that we had data from a recent geological survey conducted by Deltares that included clear spatial details about mud content in the various concession areas for sand extraction.

The ecological model based on the fine sediment model produced predictions for primary production (algal growth), as well as a direct online coupling with a shellfish grazing model. This was an essential improvement because the effects of shellfish grazing can affect nutrient recycling and therefore have a feedback effect on primary production. In the North Sea, the model focused on the invasive American Razor Clam (*Ensis directus*), which is the dominant species on the North Sea coast. In the Wadden Sea, we focused on the blue mussel (*Mytilus edulis*). The results sometimes showed surprising non-linear effects.

The model results indicated that the cumulative effect in particular of

the two sand extraction initiatives (Rijkswaterstaat and LaMER) on both the North Sea and the Wadden Sea were such that an appropriate assessment was required (an appropriate assessment is a second-stage assessment to determine effects in greater detail that takes cumulative effects with other human activities into consideration, as well as possible mitigation measures). This was a major difference with previous EIAs in which the effects were considered separately. Given the predicted impact and the fact that the ecological model contained many new elements that were not yet tried and tested, there was considerable debate about the results. Several validation and sensitivity tests were carried out and an expert review meeting was organised before the model systems and the model results were finally accepted. The result of this rigorous questioning is that, although we still have plenty of scope for improvement, we have a significantly improved modelling system that can be used for many other applications. 🌐

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Further reading:
[Van der Kaaij et al. \(2017\), Modelondersteuning MER winning suppletie- en ophoogzand Noordzee 2018 – 2027. Available at <https://www.deltares.nl/en/publications/>](#)