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Towards the application of an operational sediment transport model for the optimisation of dredging works in the Belgian coastal zone

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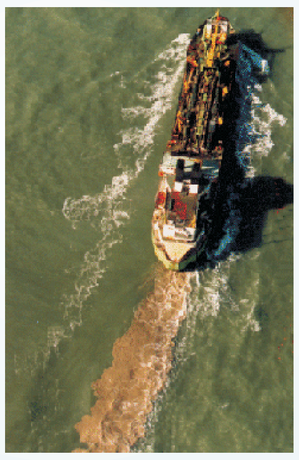
Abstract

In the Belgian Part of the North Sea, high concentration of fine-grained suspended particulate matter occurs, which is responsible for significant siltation of the ports and navigation channels. Every year, about 11 million to of dry material is dredged and dumped back inot sea. A non negligible part recirculates back to the dredging places. To study the process, numerical models are developed, validated and used in an attempt to help the authorities in the choice of an optimum dredging methodology. Different model simulations are carried out to investigate the influence of the position of the dumping sites and the meteorological conditions on the recirculation process. A first step is made in the operational implementation of a tool that can help the authorities to make the best choice for the dumping site.

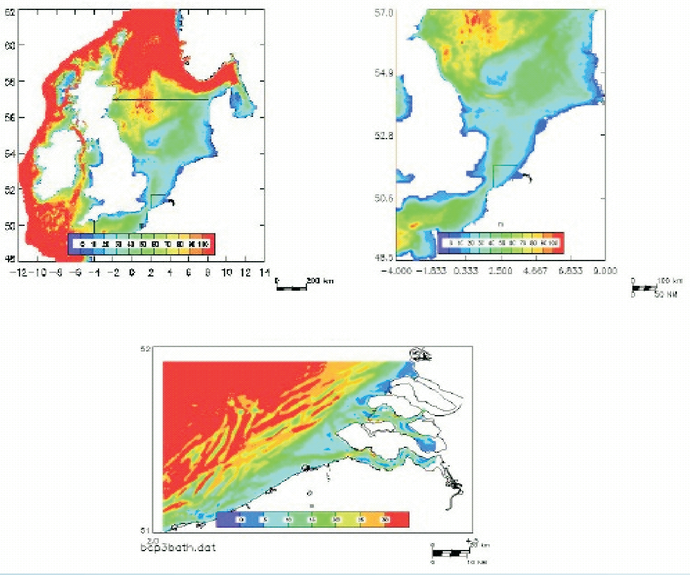
Dredging works

Dredging Mton dry material/year	Total	Mud	Sed. Rate m/year
Harbour Zeebrugge	7.00	6.96	2.9
Harbour Oostende	0.45	0.45	0.3
Pas van het Zand	1.17	0.97	0.6
Scheur Oost	1.08	0.82	0.1
Scheur West	1.38	0.99	0.1
Channel Oostende	0.15	0.13	0.1

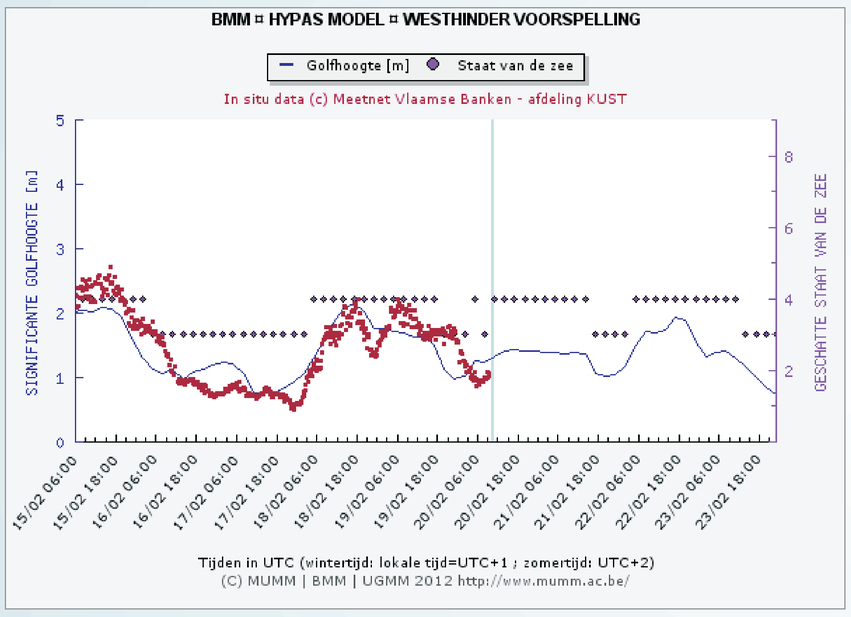
Dumping Mton dry material/year		
S1	7.54	5.26
S2	0.82	0.68
Zeebrugge	4.35	4.31
Oostende	0.60	0.57



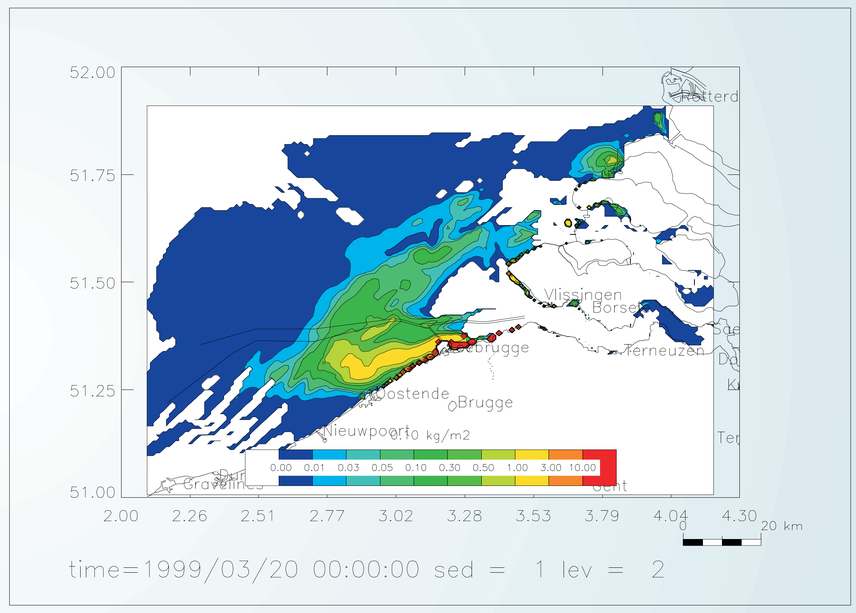
Numerical models



Currents and water elevations are calculated by the operational hydrodynamic models, based on the COHERENS software. The models comprise a 2D model for the North-West European Continental Shelf, a 3D model for the southern North Sea and a 3D model for the Belgian Continental Shelf. The models were extensively validated using ADCP measurements.

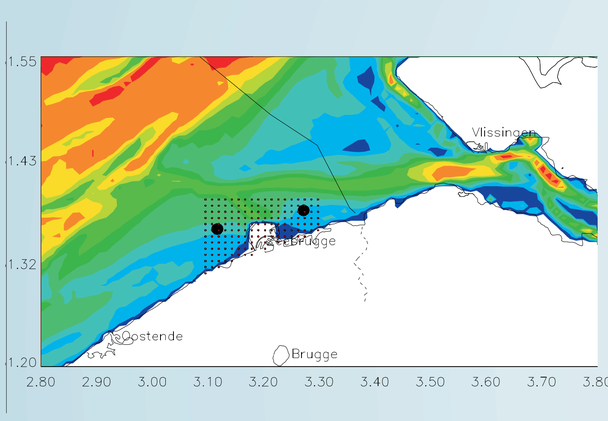


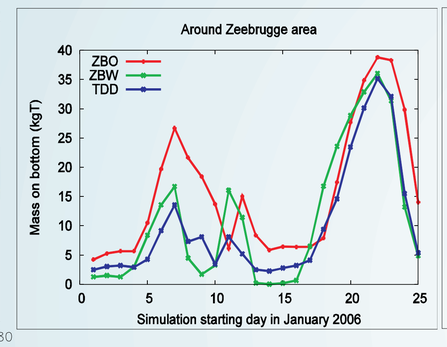
The wave model MU-WAVE is based on the 2nd generation HYPA-S wave model. A coarse grid model is implemented for the entire North Sea, a finer resultaion model is used for the southern Bight of the North Sea. The model is validated using buoy measurements of the Meetnet Vlaamse banken, Vlaamse Gemeenschap, Afdeling Kust en by comparison with results of the WAM model.

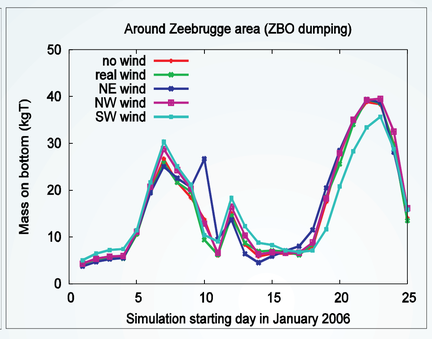


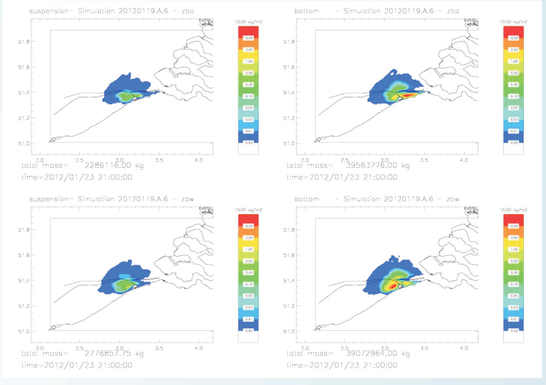
The sediment transport model MU-STM is a semi-Lagrangian model, calculating the advection and diffusion of the material in suspension. The model calculates deposition and resuspension and includes a consolidation model. The model has been validated using radio-active tracer experiments, executed by HAECON NV. The model has been used also to calculate the sediment balance for the Belgian Continental Shelf.

Tide-dependent dumping









Numerical simulations are executed to evaluate the recirculation of dumped material from the dumping sites to the zone around the harbour (see above) and the zone of the fair channels. Two dumping sites are evaluated, the dumping site ZBO and a new site, west of Zeebrugge harbour (ZBW). Also the tide-dependent dumping (dumping on ZBO at flood, dumping at ZBW at ebb) is evaluated. The simulations are done over a period of 5 days 5 hours.

Left: Amount of material on the bottom, averaged over the last day of the simulation for dumping at ZBO, ZBW and tide-dependent dumping (TDD). Right: Amount of material on the bottom, averaged over the last day of the simulation, as a function of the starting date and for different meteorological conditions. Results clearly show the influence of the dumping strategy, dumping time and meteorological conditions on the recirculation. Depending on meteorological conditions and tide, better dumping strategies can be selected, resulting in less recirculation to the harbour and to the fair channels.

Operational forecasts are being prepared of the recirculation to the zones of interest, using the three different dumping strategies and using the actual meteorological conditions. A table is prepared with the calculated recirculation. This could be used by the decision takers to decide which dumping strategy to follow during the following days, to minimise rercirculation.

Conclusions

- Numerical models (hydrodynamical models, wave models and sediment transport models) can be used to calculate the recirculation of dumped material.
- Recirculation is a function of dumping site, dumping strategy, meteorological conditions.
- Operational forecasts could help the decision takers in their decision to select the optimal dumping site, for the present situation.
- More validation and calibration of the model is necessary. A field experiment is planned for 2012-2013.

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