Model Supported Monitoring of SPM in the Dutch Coastal Zone

Katherine Cronin[1], Meinte Blaas[1], Sandra Gaytan[1] and Ghada El Serafy[1]

[1]Deltares, Rotterdamseweg 185, 2629 HD, Delft, The Netherlands

Phone: +31-(0)-616227618
E-mail:
katherine.cronin@deltares.nl

Introduction:
The Port of Rotterdam is extending its harbour facilities with the construction of the Maasvlakte-2 (MV-2). This is expected to affect the concentration of suspended particulate matter (SPM) in the Dutch Coastal Zone due to sand mining and the construction itself. SPM influences turbidity and so is an important physical variable for the marine ecosystem. It plays a crucial role in the control of phytoplankton blooms under light-limited conditions and SPM transport, resuspension and settling fluxes near the bed determine the habitat quality of benthic fauna. Natural concentrations vary on different scales because of wave and tidal action, stratification and mixing. To complement in-situ measurements for SPM as part of an environmental impact statement, the Port of Rotterdam makes use of remote sensing data integrated with an SPM transport model. This approach is referred to as Model-Supported Monitoring of SPM (MoS^2).

Methods:
A high resolution SPM transport model was set up based on the Deltares hydrodynamic (Delft3D-FLOW) and water quality software (Delft3D WAQ) along with the analysis of SPM surface data from ESA's MERIS ocean colour satellite for the years 2003-2008. First, the MERIS data was assimilated into the model in order to update and improve simulated surface concentrations of SPM [1] [2]. In order to train the models further, the data-model integration was expanded by including parameter estimation of the significant parameters to improve forecasting skills. The forecasting skill of the model is estimated for the year 2007, prior to the Maasvlakte construction.

The work presented here aims at applying the model as a reference to help detect possible trends in the SPM conditions during the construction of the Massvlakte-2. To identify trends, the model is applied to generate forecasts of the autonomous conditions during the sand-mining and construction period (2009-2011) in order to support the identification of trends in the *in situ* and remote sensing measurement data over that period.

Results: The hindcast for 2003-2008 shows improved matches of the in situ data in the coastal waters off the Dutch Coast. However, biases still exist with respect to the low-frequency observations. The model overestimates at 10-20km offshore and locally underestimates near shore. Comparison with vertical SPM profiler data show that the vertical structure is captured quite well but at occasions the observed profiles show inversions and layer structures that are not captured by the model, at least instantaneously. Comparison of the vertical means however, do indicate that previously relatively large and persistent near-shore biases have been resolved. Simulations including the dredge release volumes from the sand-mining activities show the plume moving in a predominately northward alongshore direction with high concentrations remaining close to the coast and concentrations quickly decreasing to less than 2 mg/l offshore. Results are consistent with those obtained during the Environmental Impact Assessment.

Discussion:
Detailed SPM monitoring strategies are required for the understanding and management of coastal seas. To overcome the limitations of any single observation method, the authors present an approach that integrates various sources of information to obtain more accurate insights into natural and human-induced variability of SPM. This work has improved the application of models in the support of monitoring and trend detection. The integration of MERIS data into the numerical models provided insight into parts of the coastal system not covered by measurement data. The model allows for the estimation of fluxes of SPM and provides a mean to run scenario simulations and forecasts and supports the exploration of causes and effects of activities such as the sand mining and natural changes.

Acknowledgements:
The authors thank the Port of Rotterdam, in particular Wil Borst and Onno van Tongeren. We are also grateful for the contributions of Rijkswaterstaat for providing MERIS data and in situ measurements. Thanks also to project reviewers, Julie Pietrzak, Bram van Prooijen and Arnold Heemink for their feedback.

References:
[1] Eleveld et al., (2010) *VU-IVM Report, R10-02A*, Amsterdam, 36 pp

[2] Blaas et al., (2002) *Deltares Report 1002611*, Delft.