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Sensitivity analysis of fine sediment models using heterogeneous data

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Sediments play an important role in many aquatic systems. Their transportation and deposition has significant implication on morphology, navigability and water quality. Understanding the dynamics of sediment transportation in time and space is therefore important in drawing interventions and making management decisions. This research is related to the fine sediment dynamics in the Dutch coastal zone, which is subject to human interference through constructions, fishing, navigation, sand mining, etc. These activities do affect the natural flow of sediments and sometimes lead to environmental concerns or affect the siltation rates in harbours and fairways.

Numerical models are widely used in studying fine sediment processes. Accuracy of numerical models depends upon the estimation of model parameters through calibration. Studying the model uncertainty related to these parameters is important in improving the spatio-temporal prediction of suspended particulate matter (SPM) concentrations, and determining the limits of their accuracy.

This research deals with the analysis of a 3D numerical model of North Sea covering the Dutch coast using the Delft3D modelling tool (developed at Deltares, The Netherlands). The methodology in this research was divided into three main phases. The first phase focused on analysing the performance of the numerical model in simulating SPM concentrations near the Dutch coast by comparing the model predictions with SPM concentrations estimated from NASA's MODIS sensors at different time scales. The second phase focused on carrying out a sensitivity analysis of model parameters. Four model parameters were identified for the uncertainty and sensitivity analysis: the sedimentation velocity, the critical shear stress above which re-suspension occurs, the shields shear stress for re-suspension pick-up, and the re-suspension pick-up factor. By adopting different values of these parameters the numerical model was run and a comparison between the model output and SPM values estimated from remote sensing was carried out. The analysis helped in identifying the optimal parameter values, and in identifying the spatial and seasonal dimension of the model error. The third phase focused on investigating the uncertainties of predictions of the numerical model. This research allowed for testing an approach with a coordinated use of available data from various sources, together with the corresponding sensitivity analysis exercise.

Keywords: sediment, sensitivity analysis, Dutch coast, MODIS, remote sensing, data-model integration, uncertainty analysis.