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Combining numerical models and computational intelligence techniques in sedimentation prediction

Biswa Bhattacharya (1), Thijs van Kessel (2), and Dimitri Solomatine (1)

(1) UNESCO-IHE, Hydroinformatics and Knowledge Management, Delft, Netherlands (b.bhattacharya@unesco-ihe.org), (2) Deltares, Rotterdamseweg 185, Delft, The Netherlands

Sediments are important in many aquatic systems. Their transportation and deposition has significant implication on morphology, navigability and water quality. Numerical models are usually employed to assess the impact of individual or combined anthropogenic activities by carrying out multiple scenario computations, sometimes over long simulation periods to predict suspended particulate matter (SPM) concentrations and siltation rates. For studies along the Dutch coast the numerical modelling tool Delft3D has been frequently applied to model both large-scale and small-scale sediment transport and siltation rates. While these numerical models aid in improving the understanding of the processes involved and in predicting future scenario they do have limitations as well, such as high computing time. A long simulation time is usually required due to the long residence time of fine sediments in the Dutch coastal area. A large domain size is often needed to account for the length scale of the River Rhine plume.

As an alternative we developed a hybrid modelling approach by combining numerical and data-driven modelling (DDM) to predict SPM concentrations at the Dutch coastal region. An artificial neural network (ANN) model is built using measured data and data generated by a numerical model to predict SPM time series. The ANN model uses bed shear stress (from a numerical model) and measured wave heights and wind speeds and computes SPM. The generated SPM time series is used as a time-varying sediment boundary condition at the open boundary of a fine-grid 3D numerical model of the Dutch Coast using Delft3D. Measured sediment data at the boundary is not available and as a result a fixed sediment boundary condition is normally applied. The numerical model's output (SPM concentrations) with time-invariant and time varying sediment boundary condition is compared. It is concluded that the sediment boundary condition provided by the ANN model provides improved simulation results and the methodology presents new horizons for developing hybrid models.