A Pro-active Real-time Forecasting and Decision Support System for Daily Management of Marine Works

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Marine Works involving turbidity generating activities (eg. dredging, dredge spoil placement) can generate environmental stress in and around a project area in the form of sediment plumes causing light reduction and sedimentation. If these works are situated near sensitive habitats like sea-grass beds, coral reefs or sensitive human activities eg. aquaculture farms or water intakes, or if contaminants are present in the water soil environmental scrutiny is advised. Environmental Regulations can impose limitations to these activities in the form of turbidity thresholds, spill budgets, contaminant levels. Breaching environmental regulations can result in increased monitoring, adaptation of the works planning and production rates and ultimately in a (temporary) stop of activities all of which entail time and cost impacts for a contractor and/or client.

Sediment plume behaviour is governed by the dredging process, soil properties and ambient conditions (currents, water depth) and can be modelled. Usually this is done during the preparatory EIA phase of a project, for estimation of environmental impact based on climatic scenarios.

An operational forecasting tool is developed to adapt marine work schedules to the real-time circumstances and thus evade exceedance of critical threshold levels at sensitive areas.

The forecasting system is based on a Python-based workflow manager with a MySQL database and a Django frontend web tool for user interaction and visualisation of the model results. The core consists of a numerical hydrodynamic model with sediment transport module (Mike21 from DHI). This model is driven by space and time varying wind fields and wave boundary conditions, and turbidity inputs (suspended sediment source terms) based on marine works production rates and soil properties. The resulting threshold analysis allows the operator to indicate potential impact at the sensitive areas and instigate an adaption of the marine work schedule if needed. In order to use this toolbox in real-time situations and facilitate forecasting of impacts of planned dredge works, the following operational online functionalities are implemented:

• Automated fetch and preparation of the input data, including 7 day forecast wind and wave fields and real-time measurements, and user defined the turbidity inputs based on scheduled marine works.
• Generate automated forecasts and running user configurable scenarios at the same time in parallel.
• Export and convert the model results, time series and maps, into a standardized format (netcdf).
• Automatic analysis and processing of model results, including the calculation of indicator turbidity values and the exceedance analysis of threshold levels at the different sensitive areas. Data assimilation with the real time on site turbidity measurements is implemented in this threshold analysis.
• Pre-programmed generation of animated sediment plumes, specific charts and pdf reports to allow a rapid interpretation of the model results by the operators and facilitating decision making in the operational planning.

The performed marine works, resulting from the marine work schedule proposed by the forecasting system, are evaluated by a threshold analysis on the validated turbidity measurements on the sensitive sites. This machine learning loop allows a check of the system in order to evaluate forecast and model uncertainties.