

Online monitoring, conceptual model of sediment dynamics and numerical modelling of non-tidal lagoon system

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Rødsand Lagoon is a non-tidal lagoon located in the south of Denmark approximately 10km east of the proposed immersed tunnel over the Fehmarnbelt between Denmark and Germany. The lagoon is a Natura 2000 area and home to a variety of birds, seals and other animals. It is protected by a 20-km long barrier which, under normal conditions, shelters the lagoon from incoming waves. The lagoon system is of great interest for the EIA for the Fehmarnbelt connection since spilled material from the dredging works may enter the lagoon.



Fig. 1. Overview of the Rødsand Lagoon and the measuring stations (the NS stations).

DHI, Femern A/S and University of Copenhagen have joined together to setup a field laboratory in the Rødsand Lagoon. The idea is to create an area in which data and models are abundant and where students and scientists can test ideas and developments. The first step was to set up a field test programme. DHI and Femern A/S deployed four fixed stations in the lagoon in the spring 2014. The stations measure NTU, waves, currents, wind, water levels, salinity, temperature, light, grain size distributions, and fluorescence (chlorophyll-a). Three of the stations are equipped with automatic water samplers. All stations are online which allows for monitoring of data streams and for extraction of water samples at specified times without having to be physically present. The monitoring system is scheduled to run to spring 2015. As part of the programme, DHI and University of Copenhagen also plan to hold a PhD course in the area in 2015.

As part of the monitoring campaign DHI has developed new methods for measuring light and shallow water waves using available sensors from other fields. The new sensors are smaller and cheaper than those available commercially. So far they have proved to provide similar results compared to commercially available products.

Based on the field survey programme DHI has developed a conceptual model of the area. The conceptual model describes and explains various processes governing the flushing and sediment dynamics in the area. Among the many findings are:

- that the inflow of sediment to the system happens on rising water when waves are present at the entrances;
- that local reorganisation of sediment happens during periods with small water level variations and strong winds;
- that several populations of sediment exist depending on the level of waves. This is due to floc breakup, import of external sediment and the presence of fine sand. Grain sizes are determined directly by laser diffraction technology and indirectly using water samples;

- that light attenuation is correlated to the sediment concentration;
- that calibration of NTU to SSC is very difficult due to changing grain sizes in time;
- new simpler measuring devices perform similarly to existing commercial products.

Based on the findings from the stations it has become clear that non-tidal coastal lagoons can be very complex with respect to sediment dynamics. The presented monitoring setup in combination with a 3D numerical model is a strong tool to understand the system. This is of large value with respect to general research of sediment dynamics as well as for assessing direct and indirect effects of the dredging activities in connection with nearby dredging works.

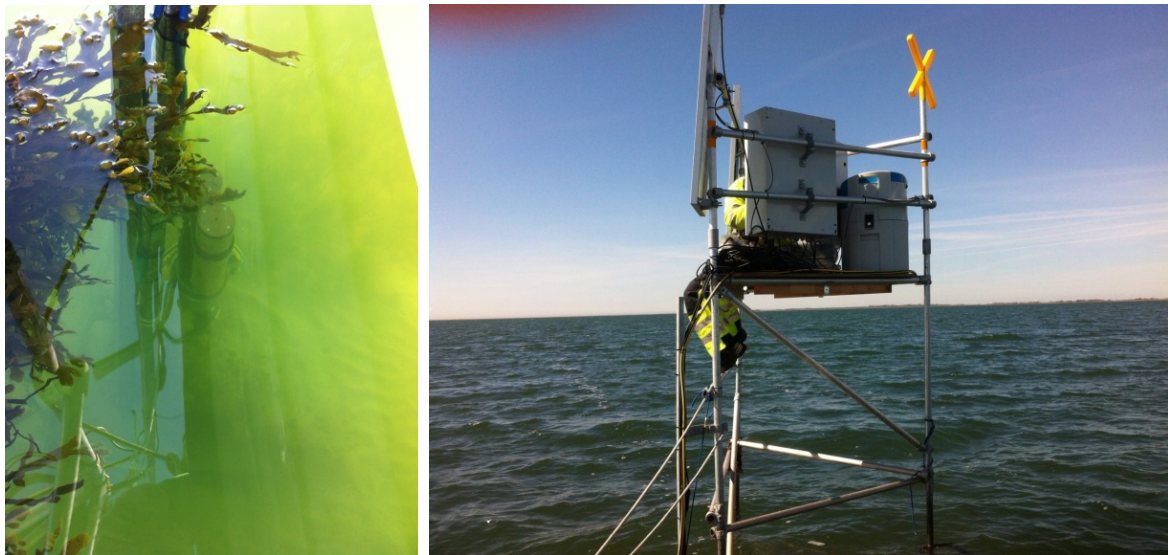


Fig. 2. NTU mounted at NS04A (left), platform station (right).

DHI will present the ideas, the findings and the challenges from measuring and modelling at the field laboratory in Rødsand.