

LONG TIME-SERIES OF HORIZONTAL WAVES, CURRENTS, SUSPENDED SEDIMENTS AND CHLOROPHYLL IN THE SOUTHERN NORTH SEA

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Introduction

This poster describes collaborative work between the National Institute for Coastal and Marine Management, Netherlands (RIKZ) and the Centre for Environment, Fisheries and Aquaculture Science, UK (CEFAS) to measure suspended sediment transport in the southern North Sea.

The objectives of this project were to:

- (i) measure continuously the suspended matter transport.
- (ii) observe the sand transport during storms.
- (iii) obtain information about the bed stability under influence of the waves originating from heavy winter storms.
- (iv) make high frequency observation at the surface and at the seabed simultaneously.

The results reported here are from near seabed observations in the Dutch coastal zone.

Approach

Near-surface measurements were obtained using SmartBuoy, described in detail by Pearce *et al.*, (2002), while near seabed measurements were obtained using a bottom lander (Minipod). The background to this work is described by Mills *et al.*, (2002).

The Minipod has been specifically designed to measure near-bed currents, waves and suspended sediment concentration profiles at high frequency and over long periods. It records data from the sensors in burst sampling mode, with data collected at 1 Hz (currents at 5 Hz) over 1024 seconds (approximately 17 minutes) every hour. Discrete water and sediment samples are also collected using autonomous samplers.

Details of the sensor and sampler payload are given below:

- Nortek VECTOR® Velocimeter mounted to record 3 dimensional velocities at 5 Hz at 15 cm above the nominal seabed
- DigiQuartz pressure sensor to record waves and tidal elevations
- 1 Dual frequency Acoustic Backscatter Sensor (ABS) for suspended sediment profiles, particle size profiles and seabed elevation
- 2 Miniature Optical Backscatter Sensors (MOBS) mounted ~ 30 cm above seabed
- A WS EnviroTech Aqua Monitor® water sampler collecting upto 50 x 150 ml water samples with one collected every 24 hours
- Seapoint Optical Backscatter Sensors (OBS) (with an autogain algorithm) mounted at 50, 70 and ~240 cm above nominal seabed
- 1 Licor upward pointing irradiance sensor 100 cm above the seabed
- 1 YSI oxygen sensor mounted 100 cm above the seabed
- 1 Falmouth Scientific Instruments Conductivity/Temperature sensor mounted 100 cm above the seabed.
- Sediment traps (or Booner tubes) mounted on one leg – either timed or passive traps

Figure 1a: Photograph of the CEFAS Minipod. The Minipod is specifically designed to measure the current, wave and suspended sediment climate using sensors that do not impede the current flow. The majority of sensors are mounted on the central "pylon". Also shown is a timed sediment trap on the right leg.



Figure 1b: A close-up photograph showing the WS EnviroTech Aqua Monitor water sampler. The syringe based sampler moves discrete water samples via a multi-way valve into storage bags mounted in boxes either side of the sampler.

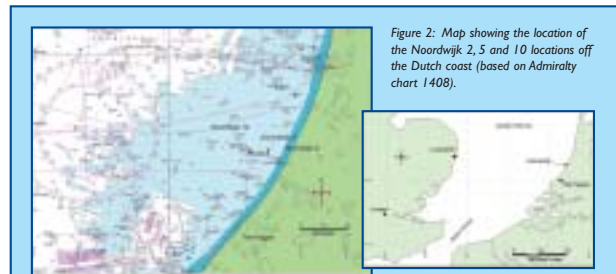


Figure 2: Map showing the location of the Noordwijk 2, 5 and 10 locations off the Dutch coast (based on Admiralty chart 1408).

The deployment, positions, water depth and durations are:

NOORDWIJK 2: 2 km offshore, 52°15'28N 04°24'28E, 10 m depth
20/11/01 - 18/12/01 Minipod 180
18/12/01 - 09/01/02 Minipod 181

NOORDWIJK 5: 5 km offshore, 52°16'55N 04°22'01E, 18 m depth
05/03/02 - 21/03/02 Minipod 182
21/03/02 - 22/04/02 Minipod 183

Calibration of suspended load sensors

Two approaches were used to calibrate the acoustic and optical sensors. Up to 50 discrete water samples, collected using Aqua Monitor, were analysed gravimetrically for suspended matter concentration and matched with simultaneous measurements from the sensors. Secondly, sediment collected in traps on the Minipod was resuspended in a tank to produce a range of concentrations and sensor measurements carried out. In both cases calibration plots were produced by matching sensor output with gravimetrically determined suspended matter concentrations.

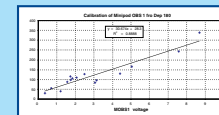


Figure 3: Calibration of the MOBS 1 mounted on the Minipod using in-situ water samples collected during deployment 180 (Noordwijk 2-1). The quality of the calibration is much improved through the use of water samples collected regularly on the platform throughout the deployment.

Results 1

Noordwijk 2

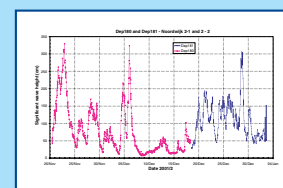


Figure 4: Time-series of significant wave height at N2-1 and N2-2 estimated from the pressure sensor on the Minipod.

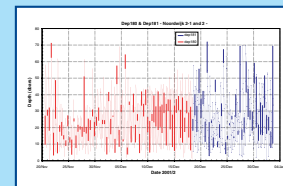


Figure 6: Time-series of horizontal speed at 50 cm above the seabed from N2-1 and N2-2 as measured by the Nortek VECTOR mounted on the Minipod.

Noordwijk 5

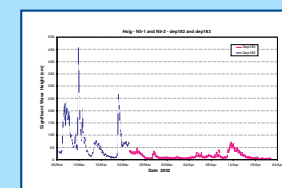


Figure 5: Time-series of significant wave height at N5-1 and N5-2 estimated from the pressure sensor on the Minipod.

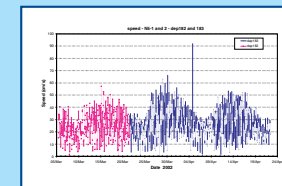


Figure 7: Time-series of horizontal speed at 50 cm above the seabed from N5-1 and N5-2 as measured by the Nortek VECTOR mounted on the Minipod.

Results 2

Noordwijk 2

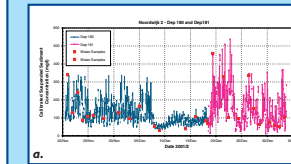


Figure 8a & 8b: Time-series of calibrated suspended sediment concentrations at approximately 50 cm above the seabed from Minipod deployment (a) N2-1 and N2-2 (b) N5-1 and N5-2. Also shown (as red squares) are the gravimetric analyses from the water samples taken by the Aqua Monitor.

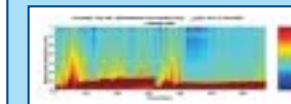


Figure 9a: Contour plot of SPM at N2-1 based on ABS data.

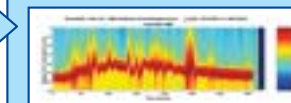


Figure 9c: Contour plot of SPM at N2-2 based on ABS data.

Noordwijk 5

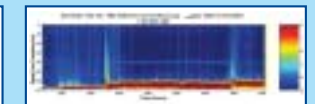
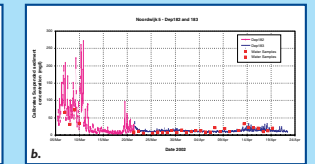


Figure 9b: Contour plot of SPM at N5-1 based on ABS data.

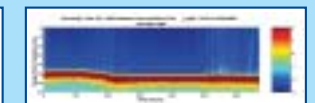


Figure 9d: Contour plot of SPM at N5-2 based on ABS data.

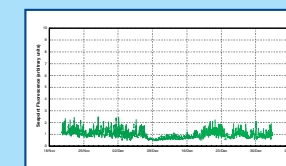


Figure 10: Time-series of chlorophyll fluorescence at N2-1 and N2-2.

Discussion and conclusions

Preliminary analysis of the results has focussed on the near seabed measurements that show generally higher background levels of suspended matter closer to the Dutch coast (Figure 8a) than further offshore (Figure 8b). Elevated levels of suspended matter at both sites (Figures 8a & 8b) are associated with periods of increased wave height (Figure 4 & 5). These results confirm findings from related work in this region (Mills *et al.*, 2002). Differences between ABS (Figure 9) and MOBS (Figures 8a & 8b) derived suspended sediment concentration reflect differences in size composition of the suspended load that has implications for calibration of sensors.

Use of Aqua Monitor derived water/sediment samples has greatly improved the quality of calibration for the optical and acoustic sensors leading to greater confidence in the robustness of our estimates of SPM concentration. Work remains to be completed to determine vertical gradients in SPM and horizontal and vertical fluxes. In addition, analysis of results on water quality parameters, including nutrients and phytoplankton, need to be undertaken with a view to examining benthic-pelagic coupling at these locations.

References

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