Grainsize variability and crest stability of a North Sea sand wave in space and time.

Ruud, T.E. SCHÜTTENHELM

Netherlands Institute of Applied Geoscience (NITG) TNO / Geo-Marine and Coast dept.
P.O. Box 80015, 3508 TA Utrecht, the Netherlands.
Fax: +31 (0)30 4564555
Email: r.schuttenhelm@nitg.tno.nl

Abstract
A four-year study started in 1999 centers on grainsize variability and seafloor stability along the crest of a particular sand wave in Dutch offshore block S2. Most data from literature suggest that due to higher current velocities and higher wave activity somewhat coarser grain sizes may be expected on a sand wave crest compared to a sand wave trough. However, the magnitude of the differences and their variability is a largely uncharted field as are the effects of moving bedforms and seasonal variations.

Introduction

Seafloor dynamics is part of the current research effort of NITG-TNO as seafloor stability is a recurrent theme in applied seabed activities. One of the projects is the DYNZEEB project which encompasses specific sand wave, longitudinal sand ridge and outer delta research. The present communication centers on the sand wave component of this project

1.Sand wave crest dynamics and variability

Sand waves in the southern North Sea are an enigmatic result of a dynamic equilibrium between sand , tidal currents and wave energy. Currents and wave action lead to sand transport and bedform movement or bedform change. The crestal part of a sand wave is the most dynamic and unstable part of a sand wave, partly because under certain conditions smaller bedforms are present on and migrate over the sand wave crest, thereby changing the crest shape and/or symmetry. Otherwise, increased wave energy may lead to increased erosion and winnowing, resulting not only in an different (reduced) sand wave height but also in grain size changes. Sand wave crests in the area under study are generally not straight but curved and bifurcating instead. This probably will have an effect on current speed and direction and so, on grainsize.

As the shape of sand waves influences tidal flow velocity, grain size changes on a profile crossing a sand wave are to be expected. The increase in flow velocity near the crest results in coarser and well sorted sand over there. This has been measured by several authors, for instance Wells and Ludwick (1974). Other authors (e.g. Terwindt, 1971), however, note that because of migration of smaller bedforms the result is not straightforward. Wave activity over a sand wave crest also tends to increase winnowing of the finer particles resulting in a somewhat coarser grainsize. Storm activity may take the whole upper part of the sand wave crest away, further compli.

Variability in time is based on amongst others movement of smaller bedforms during a normal tidal cycle. A spring tidal cycle not only enhances this bedform oscillation or migration but also changes (reduces) the shape (and the height) of a sand wave crest. See for instance Langhorne (1982). Most storms and even more so most severe storms occur in the winter season. Depending on inter alia the water depth storms affect especially the crestal part of sand waves, leading to a considerable reduction in sand wave height. See for instance Houthuys et al. (1994) and Langhorne (op.cit.).It is to be seen what the effect of a storm on the sand wave under study will be, not only as regards grain size but also regarding sand wave height. As to the latter, studies near the Goeree light platform suggest sand wave height reductions in the order of 0.5 to 1.2 m.

2.Outline of completed and planned research

A literature search for research results combining sand waves and grain size was carried out , followed by the selection of a suitable (part of a) sand wave. Two (out of five) envisaged surveys have been completed. Only the processed data and results of the first survey are now available for further study.

3.Particulars of the selected sand wave

The sand wave selected is situated in the SE corner of block S2, where water depth above the crest is 21-24 m. The sand wave height is 5-7 m. Some parts of the same sand wave are nearly symmetrical while other parts are clearly asymmetrical. The sand wave crest was surveyed in 1994 for potential coarse sand extraction purposes (Rijsdijk, 1995). The sand wave crest under study is part of a group of sand waves that show curved and bifurcating crest lines. These sand waves are situated on top of the broad and low Buiten banken linear sand ridge off the Zeeland coast.

4.Research results so far

Both in April (after the winter season) and September/October 1999 (after the summer) a short survey was successfully carried out over the selected sand wave in which 2 dozen short cores were collected as well as side scan sonar records and bathymetric profiles. On both surveys numerous megaripples were visible on the sand wave crest. Cores have been inspected and grain size subsamples at various levels taken. A first batch of Malvern particle sizer results is available. Processed side scan sonar records and 3D bathymetry are expected around the year's end. A third survey, identical to the two previous ones, is planned after the stormy 1999-2000 winter season. Thereafter, a comparison of the data sets would be especially rewarding.

Conclusion

By the time of the Lille international sand wave workshop (March 2000) first results from the various characterization techniques of the first two surveys will be available for inspection and intercomparison. Subsequent survey results will lead to answers regarding the questions and uncertainties formulated in the first section.

References:

Houthuys, R.., Trentesaux, A. and De Wolf, P., 1994. Storm influences on a tidal sandbank's surface (Middelkerke Bank, southern North Sea). *Mar. Geol*., **v. 121**, p. 23-41.

Langhorne, D.N., 1982. A study of the dynamics of a marine sand wave. *Sedimentology*, **v. 29**, p. 571-594.

Rijsdijk, K.F., 1995. Onderzoek voorkomens industriezand zuidelijke Noordzee - Detailonderzoek op de kam van een zandgolf in het blok S2. (Study of the occurrence of industrial sand in the southern North Sea – detailed study on a sand wave crest in block S2). RGD Rept. OP6533, 17 p., figs, Rijkswaterstaat North Sea Directorate/Rijks Geologische Dienst.

Terwindt, J.H.J., 1971. Sand waves in the Southern Bight of the North Sea. *Mar. Geol*., **v. 10**, p. 51-67.

Wells, J.T. and Ludwick, J.C., 1974. Application of multiple comparisons to grain size on sand waves. *J. Sed. Petrol*., **v.44**, p. 1029-1036.