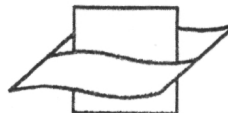


MULTIBEAM ECHOSOUNDER TECHNOLOGY
ANALYSIS OF SAND MIGRATION
WITH CHRONOSEQUENTIAL ECHOSOUNDING RECORDINGS

by **19943**

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INTRODUCTION

For hydrographic purposes swath-sounding systems become more and more important, because these systems enhance the efficiency of bathymetric surveys, when compared to the conventional methods (single track measurements).

Already in 1976 a paper revealed that, in bathymetric surveys, residual depth errors occurred as a function of the line spacing, i.e. the distance between 2 sounding lines (Ref.1).

These depth errors could be in excess of 1 metre, where the line spacing was 60 metres or more (formula $E = 0,4 + 0,1L$ with E: error and L: line spacing).

After 1976, a lot of experiments took place in the Netherlands and the United Kingdom (UK); these findings also supported the contents of the paper, mentioned in Ref.1.

A recent paper of 1993 (Ref.2) confirmed the findings of R.Cloet as well.

On the basis of this experience, it was felt imperative that, in a sandwave area, the single-beam line-spacing needed to be reduced to at least 50 metres, which was a considerable increase in the workload of the hydrographic service.

1. SWATH-SOUNDING SYSTEMS IN GENERAL

In all *three types of systems* can be identified worldwide:

- *multiple echosounders;*
- *interferometers with a sidescan sonar : phase and distance measurement;*
- *fan shaped multi-beam swath echo sounder : principle of amplitude measurement.*

Some more details about these 3 systems are given in Ref.3.

2. THE EM 950 ON BOARD THE "TER STREEP"

The Simrad EM 950, being a combination of the 2 last types mentioned earlier, is a shallow water seafloor mapping system, providing both detailed maps and acoustic sonar imaging of the seabed. The instrument is suited for hydrographic charting, location and measurement of objects on the seafloor and scientific investigations on complicated features on the seabed (e.g. sandwaves on a sandbank).

The Ref.3 provides some more details on the system specifications and on the installation on board the hydrographic survey vessel "Ter Streep" as well.

3. FIRST MEASUREMENTS WITH THE EM 950

Primarily the device has been used in order to carry out a field program for STARFISH (EC-Contract No.MAS1-CT92-0029) on the Middelkerke Bank, i.e. the assessment of the volumetric and morphological evolution trends on well chosen areas by means of a chronosequential swath echo-sounding; using this sort of echo-sounding, we wanted to examine how stable sandwaves are, as the time is passing by.

It was practically impossible to survey the whole area of the bank chronosequentially; for that reason we limited the soundings to 2 boxes, the R2- and the R4-area; here the different tracks of the survey vessel are spaced by 40 or 50 m from each other, depending on the depths nearby.

As our own equipment was not operational in time, the Rijkswaterstaat-Meetdienst Zeeland in Flushing was requested to carry out the first 2 surveys in the row.

Only at the end of October 1994 the SIMRAD EM 950 became operational on board the ms "Ter Streep", so that, from that period on, we were able to take over the task of surveying the chosen areas.

Concerning the tidal reduction of the bathymetric data, I want to refer to Ref.4, where our M2 tidal reduction method has been explained.

On the other hand, during the summer and autumn period of 1995, we surveyed also the whole of the Middelkerke Bank with our single-beam and with our multi-beam system at the same time.

4. THE RESULTS - CONCLUSIONS.

The aim of the chronosequential multi-beam echo-sounding on the Middelkerke Bank is to monitor 5 sandwaves in the R2-area and 2 bigger sandwaves in the R4-area; the global direction of these sandwaves is north-south.

The R2-area is the shallowest one, with minimum depths between 70 and 80 dm on the crests. On the other hand, the R4-area, situated in the northern part of the bank, is deeper, showing depths between 130 and 140 dm on top of the crests.

In all, we are able to produce 9 chronosequential charts of both areas, on a scale of 1/2000, for each zone. There we can notice the shapes of several underwater sand dunes and channels in between the crests.

In the 2 areas we noticed the following changes:

(1) For the R2-area:

We did not see significant changes in the bathymetry of the first 4 charts; only in the fifth, we identified a global transversal shift of 20 m to the east.

Afterwards, on the later maps, we noticed that the sandwaves gradually came back to their initial situation; in the last one the earlier situation is nearly completely restored.

Perhaps there is at first sight a geographical constraint in the position of the sandwaves. But we may assume here, that the "skin" of the top metres of the sea bed is mobile.

The transport of sediment is carried out in that upper layer and we can expect that the under-structure of the sandwaves is permanent (Ref.5).

(2) For the R4-area:

Here we do not see any significant transversal change in the bathymetry of the area: only in the longitudinal direction of the sandwaves, we can notice some movements.

We think the occurrence of oscillations, such as we see in the area R2, has to deal with:

(1) the storminess of the winter period in 1995, where a lot of severe surges occurred; it is possible that oscillations only occur in the direct period after a heavy storm; therefore, a more frequent monitoring of sandwaves, directly after a heavy storm event, would be very useful and will be done later on;

(2) the type of the tide, occurring during the storminess: on the 20th of March, there was a strong spring tide;

(3) as the depths on the crests are significantly lower in the R2-area, here the waves (due to orbital movements) touch the bottom more intensively than in the R4-area.

Here I want to refer to Ref.6, where, beside our investigations in the 2 boxes R2 and R4, we considered also the global survey of the Middelkerke bank during the summer of 1995.

REFERENCES:

1. R.L.CLOET. The effect on survey accuracy in a sandwave area. The Hydrographic Journal. Vol 2. No.4. September 1976.
2. E.C.BOUWMEESTER and A.W.HEEMINK. Optimal line spacing in hydrographic survey. The International Hydrographic Review.Vol.LXX No.1. March 1993.
3. C.VAN CAUWENBERGHE en J.LANCKNEUS. Het gebruik van de Simrad EM 950 aan boord van ms Ter Streep. Hydrographic Society- Benelux Branch Workshop on "Multibeam Echosounder technology". Oostende, 13/10/1995. Report No.42 of the Hydrographic Service. 1995.
4. C.VAN CAUWENBERGHE, L.DEKKER and A.SCHUURMAN. M2 tidal reduction method for coastal zones. Hydrographic Society-Benelux Branch Workshop on "Tidal reduction methods". Amsterdam, 19/06/1987. Rapport No.33 of the Hydrographic Service. 1987.
5. D.N.LANGHORNE. The stability of the top metre of the seabed - Its importance to engineering and navigational projects. International Hydrographic Review. Monaco, LIX (2), July 1982.

6. C.VAN CAUWENBERGHE. Assessment of volumetric and morphologic evolution trends on the Middelkerke Bank area - Chronosequential multi-beam echo-sounding by vessel: recording and processing. EC-Contract STARFISH No.MAS2-CT 92- 0029. Report No.42bis of the Hydrographic Service. 1996.

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