BSH CONCEPT AND REALISATION

Determining Survey Frequency and Resolution

Survey vessel Wega was recently deployed in the Weser estuary, where it performed a high-resolution survey of a 52 km² area, in accordance with Order 1 of S44. The sea-bottom was surveyed intensively during an extended wreck search, but this area will again be part of next year’s programme. This is no exception. German coastal waters are re-surveyed at regular intervals by the Federal Maritime and Hydrographic Agency of Germany (BSH).

The BSH uses a surveying concept that defines quality requirements such as the frequency and resolution of surveys. In order to keep abreast of recent developments and make more efficient use of available surveying time, the concept has just been reviewed and updated. The development of an effective survey plan taking into account existing framework conditions is described here.

Framework Conditions
The sea-bottom and the Wadden Sea in the German Bight are highly variable and depth changes of several metres are possible, especially close to the coast. This is the result of tidal influences in the estuaries of the Rivers Elbe, Weser, Jade, and Ems. Sand from the sea bottom has a tendency to be transported parallel to the coast, causing changes in the morphology of navigation channels. For example, the former location of the Northern Elbe navigation channel, depth 9m, is five years later covered by tidal flats. Important navigation routes, including the Terschelling-German Bight traffic separation zone, traverse this highly variable area, with shallow depths of between 10 and 20 metres. Changes in the Baltic Sea, though perhaps less dramatic, should nevertheless not be underestimated. Besides, the sea bottom in the Baltic has very high relief energy and a large number of Ice Age boulders. As in the North Sea, water depths in the Baltic Sea are very shallow; for example, the Kadetrenden, which has to accommodate the entire traffic of deep-draught vessels entering or leaving the Baltic Sea proper, offers depths of only between 17m and 27m.

Basic Survey Concept
Hydrographic surveying is carried out by BSH in compliance with the basic concept of survey tasks, which has to be approved by the German Ministry of Transport as the supreme authority. Survey tasks according to this concept have up until now been defined as rectangular areas within the limits of regular fair-sheets with a particular scale and frequency. This reflects the analogue approach of the formerly prevailing paper product, the "fair chart", which was produced exclusively on the basis of single-beam surveys. According to that method the length of sounding lines required in a particular chart area was computed on the basis of its surface. The total length of annual sounding lines multiplied with the necessary frequency of re-surveys. This is the critical parameter in the determination of the survey capacity needed. The information contained in the basic concept of survey tasks also constitutes an important basis for the annual survey plan.

Additional Tasks
Besides shipping as our traditional customer, there have been a growing number of users of hydrographic information with widely differing requirements regarding such data. To accommodate additional, for example, oceanographic work, the ship operating times for pure hydrographic surveying tasks needed to be reduced. One of the measures used to rationalise survey operations and improve efficiency is to let ships operate for longer in the survey area to reduce time spent on transit. Additional work results from the Helsinki Commission concerning environmental protection of the Baltic Sea. This requires regular high-resolution re-survey of the main shipping routes and approaches to the main ports in the Baltic Sea (HELCOM Copenhagen Declaration).

The Baltic Sea Hydrographic Commission (BSHC) of the International Hydrographic Organization (IHO) is in charge of preparing and co-ordinating this project. A working group of BSHC developed a programme that, based on IHO Special Publication 44 (S44), for the first time provides for a harmonised survey covering the entire area of the main Baltic Sea shipping routes. In compliance with Order 1 of S44, the shipping lanes are surveyed up to a width of six nautical miles. Neighbouring countries have in bilateral talks defined the exact survey areas. A re-survey interval of ten years has been agreed. These new tasks and requirements have led to the German basic concept of survey tasks having to be completely revised.

Interval and Resolution
To adjust the existing concept to the changed environment several studies have been carried out at the BSH. First we evaluated
the information available to us. This included the rates of depth change computed from available repeated surveys, and information from the masters and crews of our vessels based on their long-term professional experience. In a second step we conducted a customer poll which included our main customers: the BSH’s nautical cartographic division, the Waterways and Shipping Administration, and the German Navy, as well as other customers like the coastal defence organisations, research institutes, environmental protection agencies, hydraulic engineering companies, and archaeological institutions. About a hundred existing and potential customers were included in the poll. Some customer’s wishes were, of course, diametrically opposed. For example, the quality criteria ‘accuracy’ and ‘high level of detail’ are difficult to reconcile with ‘up-to-dateness’. Also, the requirements regarding data density covered over a wide range. To solve this problem we decided on the one hand to give priority to our important customers, and on the other to expand our product portfolio as far as possible with the available personnel. We finally chose the following main factors as criteria for the frequency and resolution of hydrographic surveys:

- importance of the survey area to shipping and other users
- variability of the sea-bottom
- depths in the area
- roughness and composition of the sea-bottom.

Revised Task Concept

Compared to the old basic concept there is now much higher differentiation among sea areas to be surveyed, according to particular quality requirements. This means the areas no longer have a rectangular shape. The transformation has been made in two steps. In the first, areas were defined to which identical resolution and accuracy criteria (including Order according to IHO S44) were applicable. In the second step areas with identical repetition frequencies were defined, taking into account parameters of variability of the sea bottom and up-to-dateness. Of course, the need for up-to-date survey data also depends on the quality requirements defined in the first step. The two steps are thus not independent of each other. Both area patterns were then overlaid and areas that were too small or had an unfavourable shape were smoothed toward the higher-quality levels. The result was a compilation of areas subject to identical quality requirements. For each of these the survey ship-time was estimated from the total length of sounding lines. The total sum thus obtained was compared to the BSH surveying capacity which, not surprisingly, was found to be too small. The process was thus optimised by iteration. The outcome can be seen in the following two graphs for the North Sea and Baltic Sea.

Figure 2 (in the magazine) shows graphic representation of the basic survey concepts for the Baltic Sea (excerpt).

Since both survey pattern and definition of survey quality for individual areas have been optimised to meet present-day requirements it has been possible to enhance the efficiency of surveying and to accommodate the mandatory additional surveys in the area of the main shipping routes. However, in order to achieve a genuine reduction in overall workload it will be necessary also to modernise existing surveying equipment and to use alternative survey methods. Modernisation is underway, and state-of-the-art, high-speed side-scan sonar have been purchased. The ongoing modernisation of multi-beam echosounding equipment will be continued.

A particularly suitable alternative method for German waters is laser scanning, which is being used in large-scale surveys of Wadden Sea areas that fall dry at low water. The data obtained are integrated with sea survey data. Other methods are being reviewed.

The draft of the basic concept has been completed this year and submitted to the Federal Ministry of Transport for approval, which means that the concept here presented is a preliminary version. The survey pattern has to be adjusted continually to the natural and anthropogenic changes taking place in the survey area. As long as this is without major impact on overall survey requirements it is covered by approval for the basic concept.

Annual Survey Plan

How does the BSH develop its annual survey plan from the basic concept? For each survey in a particular area, the year when re-survey is due follows from the basic survey concept. Every year in autumn the survey requirements for the following year resulting from the basic concept are reviewed, taking into account possible modifications in survey pattern and survey quality requirements. Also included in the review are uncompleted tasks from the preceding year and tasks that have been rescheduled to an earlier date. In addition to these internal tasks, special customer requirements are included. Major customers are asked each year to state their requirements. A joint meeting is scheduled every year in November to discuss internal and external requirements and determine priorities. By the end of the week a plan of tasks is prepared and distributed to our customers and, of course, our vessels. This approach ensures that tasks not part of the basic concept can also be included in the annual plan.

The plan lists survey tasks, required survey quality and any special features to be considered.

Working Together

Looking at the German-Danish boundary in the Baltic Sea one notices at once the unfavourable shape of survey areas close to the boundary. The fact that the shape of maritime boundaries does not follow morphological features is quite obvious in the Kadetrenden. In a bilateral arrangement between Denmark and Germany, morphologically continuous area responsibilities have been agreed for the mandatory survey tasks. The areas to be surveyed were allocated in such a way that practicable shapes were obtained. This means that Denmark’s surveys also cover some areas in the German Exclusive Economic Zone (blue in Figure 4), and vice versa (green in Figure 4). The total size of swapped areas is identical. On the basis of this arrangement Germany has been allocated the task of performing a complete survey of the Cadet Channel (as in 1997). This survey task is scheduled for 2007.

https://www.hydro-international.com/content/article/determining-survey-frequency-and-resolution