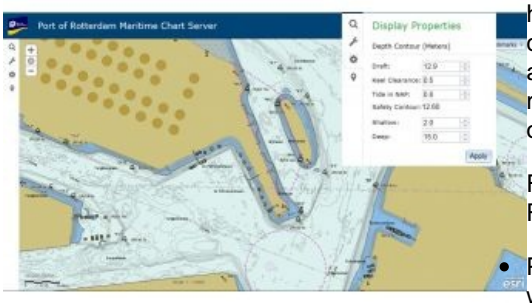
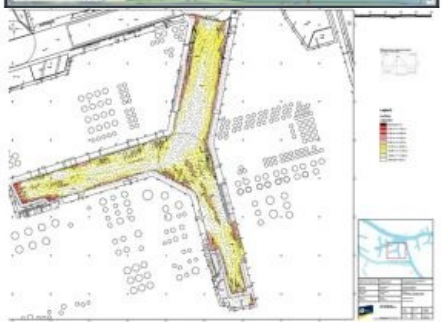
HYDROGRAPHIC SURVEYING IN THE PORT OF ROTTERDAM

Introducing GIS to Support Maritime Accessibility





With over 500 line connections to and from more than 1,000 ports around the globe, the Port of Rotterdam in The Netherlands is the cornerstone of international freight transport. It is the perfect base for import and export and a gateway to the European market and its more than 500 million consumers. However, this favourable location has one downside, namely siltation. Therefore, hydrographic surveys are conducted on a daily basis in the Port of Rotterdam using a survey programme based on siltation rates, dredging operations, port operations and client requests.

Facts & figures about the Port of Rotterdam:

- Port area: 12,500ha (land and water, of which approx. 6,000ha are business sites).
- Length of port area: over 40km.
- Employment: 180,000 jobs.
- Throughput: approximately 450 million tonnes of cargo per year.
- Shipping: approximately 30,000 sea-going vessels and 110,000 inland vessels per year.
- Added value: (direct and indirect) over EUR21 billion; 3.5% of GNP

Thanks to its strategic geographic location directly on the North Sea coast at the mouth of the Rhine River, the unparalleled depth, the absence of locks and minimal tides, the Port of Rotterdam is accessible 24/7, even for the biggest deep-sea vessels. An extensive intermodal network of waterways, railways, roads, pipelines and short-sea connections ensures an optimal connection to the European hinterland. This makes Rotterdam the perfect base for import and export and a gateway to the European market and its more than 500 million consumers. The deep-water terminals are quickly and safely accessible from the open sea. As a result, ships can be unloaded and reloaded in no time and quickly sent on their way to their next destination.

Dredging

This favourable location has one downside, namely siltation. The silt in the Port of Rotterdam originates from both the sea and the river. Siltation from the sea is transported by tide and the siltation from the river is transported by the current flow of fresh water. The annual siltation in the port area varies between 5-6 million m3. Dredging operations are an ongoing business to keep the port accessible for all vessels and especially deep-sea vessels with a draught of more than 23 metres.

Surveying

Hydrographic data is critical to the Port of Rotterdam's operations.It must be extremely accurate and supplied in time. Understanding the depths throughout the port is a critical piece of information for the Port of Rotterdam's day-to-day work. As the Dutch Hydrographic Office only produces ENCs for harbour usage, the Port of Rotterdam investigated the possibility of producing 'berthing' ENCs containing high-density depth data to support decision making within the port.

Hydrographic surveys are conducted on a daily basis in the Port of Rotterdam using a survey programme based on siltation rates, dredging operations, port operations and client requests. This is mostly scheduled, but it needs to be flexible to monitor the dredging operations.

The port operates two survey vessels on a daily basis. The survey vessels *Surveyor 1* and *Surveyor 2* conduct at least three surveys per day. Furthermore, the rib Calypso was added to the fleet to operate in shallow survey areas.
Surveyor 1 and *Surveyor 2* are equipped with the latest Teledyne Reson multibeam echo sounders, Applanix Inertial navigation systems, Riegl laser scan systems, Valeport SVPs and operated by QINSy and five hydrographic surveyors.

Multibeam surveys contain overlapping tracks for quality assurance and checks for sound velocity changes. The noise is removed by depth area cleaning filters. The survey data is processed on board on the day it is collected. Noise is removed from the survey and checked by Beamworx's Autoclean. All surveys have to meet the Port of Rotterdam Survey Standards for multibeam surveys.

A mean 1x1m grid is generated after cleaning the data to reduce the amount of data. On slope areas of bottom protection rock dump areas, a mean 0.5 x 0.5 grid is created to retain bottom integrity. Once the survey has been fully processed, it is sent as a clean 1x1m digital terrain model (DTM). The survey vessels are connected with the Port of Rotterdam network by UMTS cellular connections. The survey data can be copied to the network drive that is monitored.

The New GIS: PortMaps

In 2013, the Port of Rotterdam decided to partner with Esri to replace the old GIS with the implementation of the PortMaps system. Portmaps, built using the ArcGIS platform, is an integrated information system for all Port assets. The platform had to be user friendly, so all users could find information at the port within three mouse clicks. The Port of Rotterdam also required an adaptive system to handle facilities management, accommodate mobile devices, and integrate with its other corporate information systems: SAP, Microsoft (Sharepoint) and DMS (Document Management System).

PortMaps is an asset management system and provides the framework for the hydrographic production at the port. The hydrographic system consists of three primary components: the Bathymetry Information System (BIS), the Nautical Information System (NIS) and the Maritime Chart Server (MCS).

The BIS is the bathymetry database for the port and replaced the Oracle database Dolomiet developed in-house. When Esri and the port implemented the BIS, the port identified several metadata attributes that they wish to track and maintain for each survey. Over 3,500 surveys were extracted from the former bathymetry database, Dolomiet, transformed into dual-band GeoTIFFs, and registered along with their associated metadata with the BIS.

The NIS is the base geodatabase for the Esri Nautical Chart production system. Using the ArcGIS for Maritime, Charting solution and extract-transform-load (ETL) processes, information from various sources was combined to populate the NIS. ENC cells from the Dutch Hydrographic Office are then augmented with information from the Port of Rotterdam's existing port ENC cells and information from the Port Object Information database (POI).

With the implementation of the PortMaps project, harbour masters, asset managers and pilots have access to Esri's Maritime Chart Server (MCS). MCS serves the most current ENCs available for the port, including some created by the port with depth information surveyed that day. MCS gives the organisation of the port as a whole access to dynamic querying on the rich data contained within ENCs in order to assist with planning and domain awareness.
A dredging-atlas is created by PortMaps to support the dredging activities. This atlas features a difference layer between the maintenance depth levels and the survey data in the BIS. The layer thickness is displayed as an information product, but also on 'paper charts'.

ENC Production

With the bathymetric base of the port's ENC stored with the BIS, the next production step is to manage and update the other ENC features. All of the non-bathymetry ENC features are stored in the NIS database. An ETL extracts data and transforms it into the S-57 data model.

When an ENC update is required, the ENCs can be exported easily from the NIS. The tools use an ENC cell coverage layer to select and batch export ENC cells that need to be updated.

In the next stage of production, the exported ENCs do not include any bathymetric information. To complete the S-57 ENC, the Data Management office uses QINSy by QPS. In order to reduce the depth data in the ENC, a process is run overnight on the complete bathymetric surface model maintained by the BIS. The process takes the 1x1m model and generates a 5x5m grid. The process selects the shallowest grid depth within the 5x5m grid and writes the depth and the original horizontal coordinates to the 5x5m grid. This results in a 5x5m irregular DTM of shallowest depths.

An average hydrographic survey in Rotterdam covers three ENC cells of four square kilometres each. Processing this survey from vessel to ENC takes only a few hours of direct user involvement. The combined workflow of the hydrographic survey collection, processing and ENC production is generally finished within two days.

Once the ENCs have been updated, they are made available to a wide variety of different uses in the Port of Rotterdam. The two principal ENC consumers are the Port Authority and the Pilots. Both these groups use the information in different formats to assist in the safe navigation of ships with marginal UKC.
Any ship that is limited to the fairway by draft has to call in to the Port Authority at least 48 hours ahead. When the ship calls in, the Harbour Masters' office (HCC) checks the fairway and berth depths using MCS. The HCC officer can enter the ship's draft, UKC and the tide level into the MCS user interface. The safety contour will be derived and shown automatically in MCS.

Conclusion

Hydrographic surveying is one of the important parts of port operations as vessels are using less keel clearance for maximum loads. Safe navigation needs regular surveys, delivered on time and to specified accuracies.
Data errors are significantly reduced and data is synchronised by joining the GIS activities of all asset management departments of the port in PortMaps to update the S-57 objects. This directly impacts decision making in vessel traffic management.

The level of data synchronisation at the Port of Rotterdam directly impacts how the port manages traffic and vessel safety. Because the hydrographic production system is so closely linked and integrated with the port's enterprise GIS, the hydrographic data is easily utilised by all areas of the port. This innovative approach to hydrography truly allows the data to be used for more than charts and creates potential for hydrographic data outside of traditional uses.

https://www.hydro-international.com/content/article/introducing-gis-to-support-maritime-accessibility