Study project ”Surveying of the Swedish coastal zone”.

The project has been funded by a grant from the Swedish Civil Contingencies Agency (MSB)
Cooperation partners is the Geological Survey of Sweden and the Swedish Land Survey

The project aim has been to conduct a methodological study to find cost-effective tools for measuring the shallow waters of the coastal zone as well as lakes and streams. With shallow water we here mean from the shoreline down to a depth of about 10 meters. Within this area there is a great need to have high-resolution in order to create reliable flood and dispersion models, detect and calculate erosion damage, and make analyses of climate's impact on the sea level. A prerequisite for this is a coherent terrain model for the coastal zone and other waterways. The recent high-resolution elevation data from the National elevation database can be used for terrain models on land but which ends as soon as the water begins. Today very little high-resolution data exists in these shallow waters, both due to that traditional measurement methods are very costly in shallow areas, but also the SMA financial model where our income is from the fairway and pilotage fees, hence our main priority has been the main fairway areas.

Performed work

We have looked into airborne laser system (LIDAR), interferometric sonar, etc. An analysis of the different measurement methods and their effectiveness in shallow water areas has been made. The measurement efficiency, particularly LIDAR technology but also acoustic methods, in large depends on the physical characteristics (quality) of the water such as turbidity and vegetation. An feasibility study for LIDAR surveying of the coast has been made and it has been found that we have only a limited window of four month in the fall that is suited for LIDAR surveys. This time of the year may not be the very best regarding shallow bathymetry for nautical purpouses as the vegetation then is at a peak level, but for other uses like environmental monitoring it is preffered to be able to identify the vegetational fields. Lowest turbidity seems otherwise to be in the very beginning of the year but then we lack sunlight, for simultaneous airphotogrametry, and we have icecoverage in most Swedish coastal waters. A course planning for LIDAR survey has been done in order to give us a cost estimate and a possible timeframe for a complete coastal LIDAR survey.
As test operations with airborne technology is costly, we have primarily used support of external experts (procured) for the planning, and analyzes of results from earlier tests whith LIDAR systems nationally as well as internationally.

Areas to test accoustic equipment and methods has been selected from different types of shallow coasts. In one area we experienced very dense seagrass that was very troublesome to survey using multibeam. The best results for this particular area came from the GeoSwath 250kHz system. The Reson and Imaginex data collected was very poor and only usefull in a very narrow swath angle. For best results, areas whith dense vegetation needs

to be surveyed very early in the year. A test (outside of this project) of the new RESON T50-P multibeam that uses multi-detect was done in April this year and gave a promissing result that might help the problem to survey on vegetated bottoms as it doesn't only detect the shallowest echo.

Final results

The results of the study will be the basis for a discussion regarding the needs and funding to establish a national coastal zone mapping program. The depth database can, when filled also whith shallow surveys, be used together whith the national elevation database to create a seamless digital terrain model over the Swedish land and water areas.

The enquires we made during the project gave the impression that many has too strong believe in what actually is possible to achieve when it comes to accuray and resolution of bathymetric surveys. Some wanted to have a vertical uncertainty of 2-5 cm and 5 cm resolution of the datasets. Such datasets is nearly impossible, both to achieve and far to large datasets to be possible to handle by standard GIS-tools.

We have though realized that we need to update the demands in the present realization of S44 (FSIS-44) for areas outside fairway areas with depths 0-10 m that is used for private boating and smaller passenger ferrys. At present time, for areas that doesn't belong to "fairway areas", we only demand surveys to fulfill Order 1a. This is not enough for private boating and passenger ferrys as it would mean that, in a newly surveyed area, we can accept shoals of ≈0.5 m outside of the 3 m depth countour. Today we are only demanded to find cubic objects 2 m or larger and at the same time allow a vertical uncertainty of 50 cm (95%)! In the report we suggest a "Special order"(cubic objects 0.7 m) to be fulfilled in navigable areas outside the "fairway areas" in the interval 10-3 m. For 0-3 m of waterdepth, in order to reduce costs, we suggest "Order 1a" whith a strengthened demand to find cubic objects of 1 m. This means also that we will need to use multibeam surveying between 3-10 m of depth.
It is also clear that multibeam backscatter as well as SBP data should be collected from all surveys made by boat. Multispectral photogrametry should be collected from any LIDAR surveys and the LIDAR reflectivity should be processed and stored as a separate dataset.

Costs

Calculated cost for a primary survey of the entire coastline 0-10 m using Bathymetric LIDAR is 34 M€ (including data handling and chart updates of 3.3 M€) and could be achieved in a 5 year period using 4 month per year and two airplanes.
The cost for a multibeam survey of all waters between 10-3 m is calculated to be between 92.5 and 114 M€ (including data handling and chart updates of 8.95-11 M€) and the survey time would be between 81 and 100 years using only one boat (20-25 years using 4 boats).

The report suggests that as a test a full survey by LIDAR and multibeam should be done in one or two suggested counties, Uppsala and/or Halland for a total cost of between 4.9 and 5.7 M€ for Uppsala and between 3.8 and 4.4 M€ for Halland.

Project Manager: Hans Öiås