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TopoBaty project -Testing LiDAR mapping in the coastal zone of Norway

Summary of the final report

Background

At the 58th NHC Conference Norway presented some preliminary results from the pilot project *Topobaty 2014*. Action Item 14 from NHC58 tasks Norway to inform MSs about the final results and experiences of the TopoBaty pilot at NHC59. This summary is based on the report delivered by the Contractor and on the final evaluation report prepared by the Norwegian Hydrographic Service (NHS). The last report from NHS was available on 24 March 2015. For this reason the outcome of the project is at the time of writing not been considered and commented by the managements team at NHS.

The NHS launched the TopoBaty 2014 project to see whether the last generation of topobathymetric lasers had the potential to be utilized for the surveying of the Norwegian coastal zone (sea and land). One goal was to gather sufficient knowledge to be able to plan future surveys, including where this method is suitable for the purpose, economically favorable and what to consider when preparing calls for tenders. We expected to reached sufficient coverage on the sea side down to 3-5 meters

After a tender process, the Danish company NIRAS was awarded the contracted for the laser data collection and data processing. NIRAS subcontracted the Austrian company AHM for a part of the work. The Topo-Bathymetric Lidar Scanner *Riegl VQ-820G*, with pulse repetition 256 Hz, was used, together with cameras (ordinary, video and termal).

Description

Ten small areas close to Stavanger were selected for the project, se Figure 1. The surveying took place during three days in April 2014. The main part the surveying was done from approximately 500 meters height, resulting in a circular footprint of approximately 0.5 meter in diameter.

Three of the areas are within a NHS hydrographic test field, with an established reference surface and several accurately positioned bench marks. These areas were surveyed with different settings and NHS planned to do a more detailed analysis from the test field. Unfortunately, the data collection from the test field were of lower quality than the average, mainly related to lack of detection due to water conditions and the brightness of the seabed. Even with some identified corrections applied, these data contained lack of coverage in some shallow areas. Improved datasets were delivered too late to be analyzed for this report.

The other areas represented typical challenges for the Norwegian coastline such as steep mountains, beaches, harbors, river deltas and challenging water quality or seabed conditions. The fjord area Frafjord was investigated in greater details than the others as data collection was done from different heights (300, 350, 550, 600, 700, 950 and 1000 meters)

For all areas NHS asked for processed data down to 5 meters below chart datum (typically 5.6 meters below mean sea level in these areas). Construction of Digital Terrain Models (DTMs) were a planned outcome.

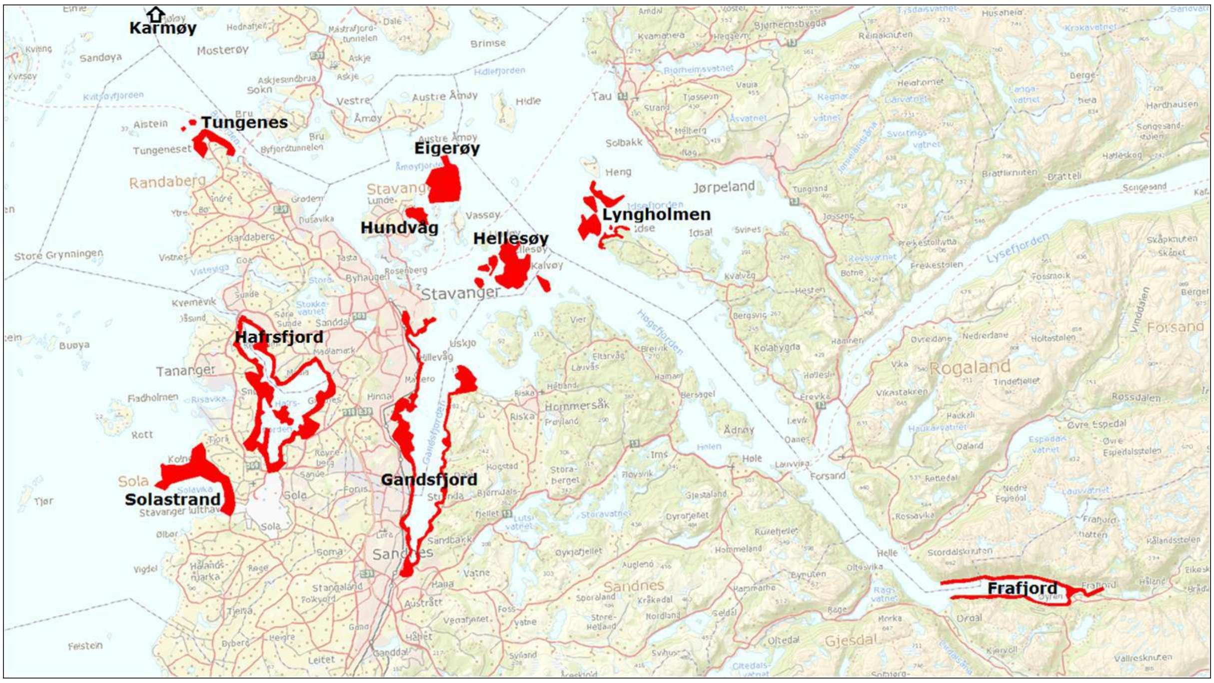

Figure 1. The areas shaded in red were covered (the location Karmøy further to the north is not shown)

Analysis

The Contractor has described the data acquisition, deliveries, processing, accuracy assessment, classification etc. in a final report. The data deliveries were quality controlled by NHS before used for any analysis.

Comparison of laser data with results from multibeam surveying

This analysis aimed at getting some statistics of the deviations between the datasets. Some of the surveyed areas had insufficient coverage of multibeam. Generally the laser data showed somewhat greater depths (~0.2m), but with some variations from area to area. With increasing depths the laser data coverage decreased, making it difficult to derive proper products like DTMs. A too strict classification of the data (done by the Contractor) reduced the amount of acceptable data in the deepest parts.

Evaluation of accuracy

All observations were reduced to chart datum. The laser observations make it possible to establish a well-defined model for the water surface. Observed water levels were used for verification.

The bench marks from the test field areas should give an indication of the accuracy of the laser data and also the ability to detect objects. The improved datasets have not yet been fully analyzed, but some graphs in the report give the impression that only a few of the bench marks are detected in a satisfactory way. The comparison was done in areas where there was sufficient detection with LIDAR at the same depths as the bench marks. A further evaluation might bring more information that is useful. Some evaluation done for a different location also demonstrate some problems in drawing conclusion about the detection of objects or the shallowest part of a shoal. Further evaluation is recommended before concluding on this subject.

Evaluation the terrestrial data
The main part of the evaluation was done at an early stage of the project. Generally, an offset was detected, but with a rather small standard deviation. It is expected that with a proper reference surface available, the offset would be significantly reduced.

Evaluation of laser data usability
The automatic classification of the data has grouped quite a lot of the observations as “rest”. This class comprise signals from vegetation, turbidity, steep slopes etc. The evaluation indicate that the automatic classification rejects many observations that should have been accepted as bottom detection. A dark bottom reduces the return signals largely. There is several situations where shallow dark areas have no bottom detection and end up with gaps in the coverage.

Observation density and observation depths
The number of observations at different depth intervals varies significantly from location to location. The reason for this is partly related to the darkness of bottom and the “rest” classification algorithm. Plots of coverage is constructed for grid size of 5x5 meters and 1x1 meters within the different survey areas. This product also contains the 5 meter depth contours and gives an immediate impression of how many observations are available at different depth intervals. In the most successful locations reliable observations are available at 3-4 meters depths.

Conclusions

The following conclusions are made based on the NHS analysis of the laser data:

- The automatic classification algorithm used by the Contractor should be improved. This will increase the number of successful observations and increase the likelihood for better derived products, like DTMs.
- The results of the surveying vary from area to area, but also within a specific area. The main reason for the variations seem to be related to the color of the bottom. Dark bottom give less return signals
- In the most successful areas, reliable observations down to 3-4 meters, referred to Chart Datum, are obtained.
- In a future utilization of laser, improved specifications and control mechanisms should be available
- Reference surfaces should be available on land, and preferably also for the sea, for calibration purposes in advance of survey campaigns.

Actions requested from NHC59

The NHC59 is asked to note this information