REPORT FOR LIDAR DATA CAPTURE

L40925 SYKE HySpex

terratec

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Report prepared,

Oslo, Norway, 06.09.2018

Vetle Jonassen

Project manager

1. General Project Information

1.1 Client

Name:	Blom Kartta OY
Address:	Esterinportti 2, 00240 Helsinki, Finland
Project manager:	Lasse Turunen
Project reference:	18068_AP

1.2 Project

Name:	SYKE HySpex
Country:	Finland

1.3 Contractor

Name:	TerraTec AS
Address:	Vækerøveien 3, 0281 Oslo
Project manager:	Vetle Jonassen
Project reference:	8739

1.4 Coordinate System

Horizontal datum:	Euref89
Projection:	UTM35
Vertical datum:	FI-N2000

1.5 General Project Description

The purpose of the project was to get a continuous laser scan of the requested area which could also provide a 50 cm digital surface model.

Scan angle: Maximum ±15 degrees from nadir.

Missing coverage: Missing coverage in the lidar data was only accepted if they were caused by water surfaces or low reflective surfaces.

Lidar data classification: The Lidar data was classified into classes 1 (default), 2 (ground) and 7 (Noise) according to the LAS 1.2 standard.

1.6 Project Coverage

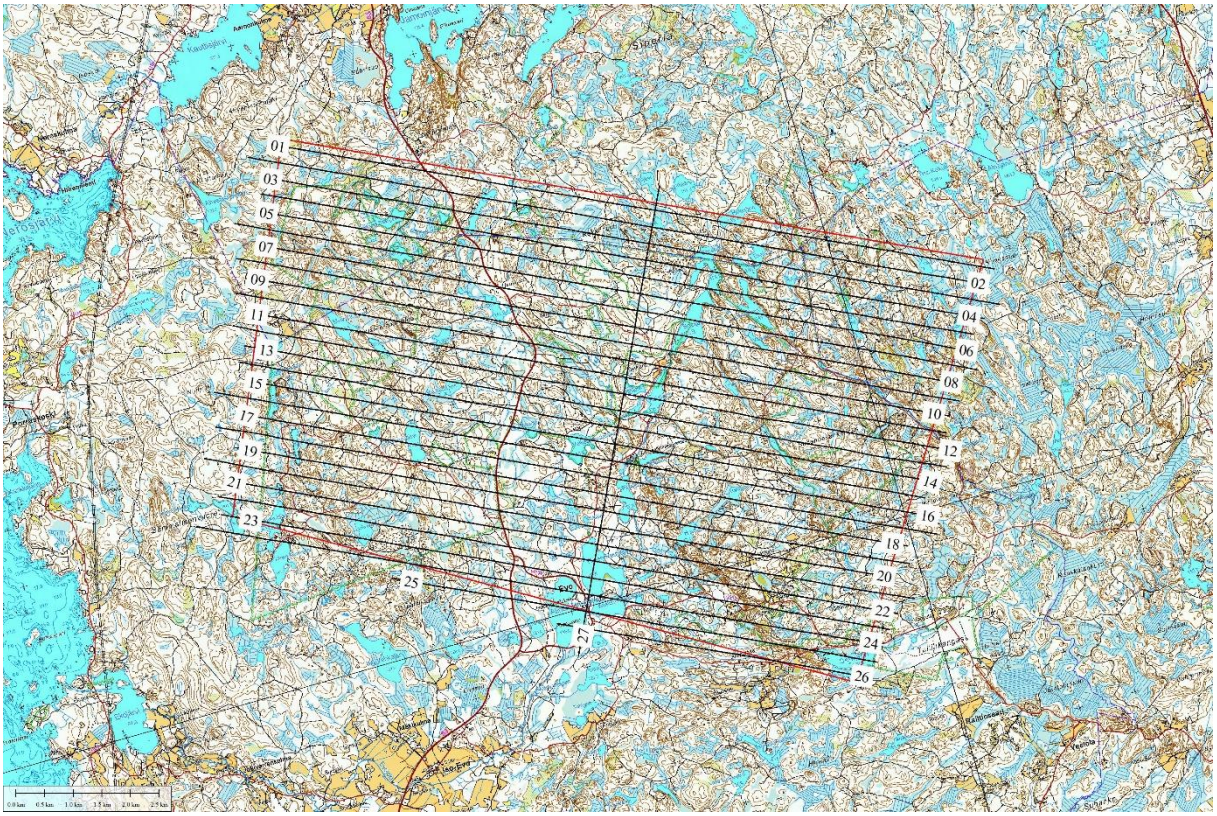

Figure 1: Center lines of acquired data.

1.7 Quality Assurance

The project is executed according to Terratecs quality assurance system. On this project, the following aspects have been emphasized.

- Calibration of sensor system
- Establishment of an on-site calibration field for regular monitoring
- Crossing calibration lines
- Matching of flight lines
- Adjustments and control by measured points

2. Ground Control Points (GCPs)

Ground control points were delivered by the client. These points were high accuracy measurements within the area borders, and were later used to correct the laser points.

3. Data Acquisition

3.1 Sensor System

The high-accuracy sensor system Leica ALS70-HP was used for this project.

3.2 Sensor Calibration

Calibration of our sensors are performed by both the sensor manufacturer and TerraTec.

3.2.1 Factory Calibration

The manufacturer performed sensor calibrations. The calibration report and system parameter set were delivered along with the sensor. Factory calibration was also performed after repairs/upgrades and periodically according to service and maintenance plan.

3.2.2 Calibration of Installed System

A calibration was performed at first time installation in aircraft, with changes in factory calibration or changes in the physical installation. In this calibration, angle differences between components are solved and lever arms between GNSS antenna, IMU- and laser sensor were estimated. The lasers' range correction parameters were controlled against surveyed control points on ground.

3.3 Coverage Number

Coverage SYKE HySpex was given coverage number L40925.

3.4 Execution of Data Capture

TerraTec AS has carried out the LiDAR data acquisition in the following operations:

Line number:	Operators	Date
1-27	Vetle Jonassen and Markus Unt	2018.07.16

4. GEOREFERENCING THE POINT CLOUD

4.1 Navigation Processing

Processing of the navigation data was done with the software TerraPos. The software is developed by TerraTec AS.

In this process, observations from an inertial measurement unit (IMU) and GNSS were combined in a Kalman filter. This procedure is commonly known as "tightly coupled" processing. Together with a reverse filter recursion ("RTS smoother") the result gave an optimal statistical estimation of parameters. As a minimum observations from GPS and Glonass are used in the calculations. Galileo and Beidu can be included if available.

4.1.1 Evaluation of the Navigation Processing Result

All navigation processing used in the delivered LiDAR data were evaluated. Magnitude and stability of the estimated errors of the IMU were checked to detect anomalies or problems with sensor integrations.

All the navigation solutions in this project are found satisfying. Estimated values for antenna lever arms showed that they coincided with theoretical values.

4.2 Georeferencing the Point Cloud

4.2.1 Transformations

The navigation solution in TerraPOS was processed in WGS84.

4.2.2 Point Cloud Processing

The point cloud was processed using the system manufacturers' software. Factory calibrated values and installation values are used to calculate point clouds for each flight line. The point clouds were outputted in WGS84 UTM35.

4.2.3 Project Calibration

A calibration per flight session is performed. Correction values for heading, roll, pitch and altitude were estimated and applied if they are found significant and reliable.

Evaluation of results:

No abnormal values have been found during this process.

4.2.4 Flight Line Matching

A relative matching was performed to solve for random deviations between flight lines. Best match in roll and altitude between lines were calculated. All flight lines are involved in the calculations. The matching is evaluated by calculating elevation differences between flight lines in areas where they overlap.

Evaluation of results:

No abnormal values has been found during this process.

4.3 Lidar Coverage Control

A manual inspection was done to ensure that the whole area of interest was covered by the point cloud.

4.4 Control Against Ground Control Points

Average difference between five ground control points acquired by the client and the LiDAR points were used for adjustment. The adjustment of the LiDAR points is given in the table below:

Minimum dZ (m)	Maximum dZ (m)	Average dZ (m)
-0.269	-0.200	-0.232

4.5 Conclusion Georeferencing

The results from calibrations, matching and control against known points showed that the data was of very good quality and well within the expected values.

5. Point Cloud Classification

Automatic methods were used to classify the point cloud. In this project the laser data was divided into the following classes:

1) Unclassified
2) Ground
7) Noise

5.1 Ground Classification

Terrain surface points are classified as class 2. This class also contain points on water surfaces where these have reflected the LIDAR beam.

Classification of ground points is the most time-consuming part of classification. In this process automatic filtering through defined algorithms is performed. The challenge with this filtering is to find the parameters that is best at picking out points that are describing details in the terrain surface not adding vegetation or other features that are not considered ground. Factors that influence the choice of parameters are point density, topography and the density of vegetation coverage.

5.2 Noise Filtering

Noise points were filtered out. These are erroneous registered points caused by multi-path reflections, airborne particles (e.g. water, dust) or objects like for example birds. Most of these points were filtered out by automated classification routines.

5.3 Non-Ground Classification

Points that are not considered to be ground or noise were classified as class 1.

5.4 Evaluation of Classification

The classification in this project was quality approved by the project manager.

6. DELIVERY OF POINT CLOUD

Las-files are divided into 1000x1000 meter map sheets.