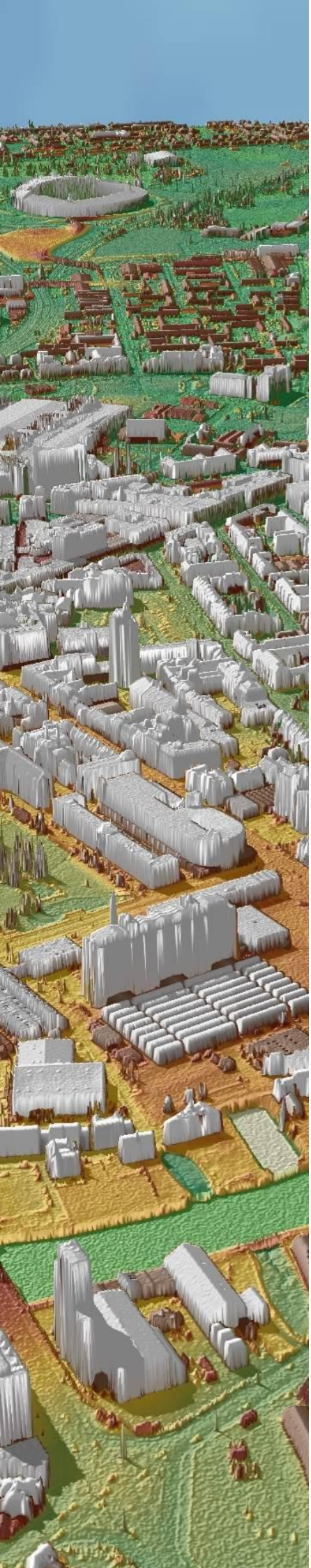

Geomatics

Environment Agency, National Operations

LIDAR QUALITY CONTROL REPORT

PROJECT: PM_1478

Processing of LIDAR data for the South West TELLUS Project

Integrated spatial solutions

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LIDAR Quality Control Report
Project PM_1478

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This report was approved by

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Geomatics Manager

Date: 03/04/2014

Contents

Appendices

1.0 Introduction

This report relates to the processing of LIDAR data for Devon and Cornwall. These data were acquired and calibrated as part of the South West TELLUS Project by the British Antarctic Survey (BAS).

The Environment Agency was requested to assist in the final processing of these data to produce both a Digital Surface Model (DSM) and Digital Terrain Model (DTM). The DSM is a raster dataset that contains the ground surface and all objects above it, the DTM is a raster dataset that contains only the ground surface.

The requirement was for automated processing without intensive manual interaction. This, combined with the operating parameters used during collection and calibration, had the potential to affect the overall height accuracy. Comparisons were therefore made against ground truth surveys to enable comment to be made on data quality.

This report describes the basic processing carried out and the quality achieved.

2.0 Data Processing

Geomatics used automated procedures to produce DSM and DTM layers from the BAS calibrated point cloud. The LAS data were processed through Terrascan in 1km x 1km blocks using the standard 1m resolution classification macros. These macros classify the point cloud into ground points and surface objects. A secondary DTM that retains ground points on steep slopes was also produced to be used at a later point for definition of coastal cliffs.

Data were than taken into ArcView using modified versions of standard Environment Agency scripts and a newly developed routine to mosaic overlapping 4x4km blocks. A 50m overlap was applied between adjacent blocks.

An automated routine was used to fill no data gaps in the DTM above a determined size threshold. No additional breaklines were used, which means that the auto-filling may result in triangulation effects in some locations.

For standard Environment Agency LIDAR products, extensive manual editing is carried out on the automated DTM. For this project, no manual editing was applied so the results were as produced by the Terrascan macros. This may result in some large buildings and bridges being left in, some tree stands having not been taken out and some cliffs being taken out that should have been left in.

Also, as the LIDAR data were captured during the summer with leaf-on conditions, it is not possible to see locations where the laser pulses have not penetrated the vegetation. This may result in false ground levels.

Automatic cliff-retrieval from the secondary DTM was then carried out by merging back into the DTM cliffs within 100m of the Ordnance Survey mean sea level line, where there was a difference of 50cm between the DTM and secondary DTM.

The overlapping 4x4km blocks (both DTM and DSM) where then clipped and merged (using smooth feathering) into regular 5x5km blocks, and exported in ESRI Binary GRID, ESRI ASCII Grid and geo-referenced JPEG format, named after their OS grid reference.

Data were imported into an ArcGIS GeoDatabase and mosaiced into one seamless DTM and DSM, with hill-shading applied.

3.0 Ground Control

Geomatics have compared the DSM and DTM layers to existing LIDAR and data from 74 random GPS ground truth sites.

Appendix A includes a plot of the data showing coverage with locations of independent ground truth sites.

Appendix B shows the comparison of the LIDAR and Ground Truth surveys.

Ground Survey Site	Site reference number	Polygon	RMSE
Average	74 random sites	South West Tellus DTM	0.095

4.0 Data Delivery

The Digital Terrain (DTM) and Digital Surface Models (DSM) are delivered as 5 x 5km tiles in ASCII Grid, ESRI Binary Grid and quick-look JPEGs for each Ordnance Survey tile.

We have also resupplied the Point Cloud LAS data.

ASCII Grid: The ASCII raster file format is a simple format that can be used to transfer raster data between various applications. It is basically a few lines of header data followed by a grid of cell Z values. The header data includes the following keywords and values:

ncols	- number of columns in the data set.
nrows	- number of rows in the data set.
xllcenter or xllcorner	- x-co-ordinate of the centre or lower-left corner of the lower-left cell.
yllcenter or yllcorner	- y-co-ordinate of the centre or lower-left corner of the lower-left cell.
cellsize	- cell size for the data set in m.
nodata_value	- value in the file assigned to cells whose value is unknown. This keyword and value is optional. The nodata_value defaults to -9999.

For example:

ncols 480
nrows 450
xllcorner 378923
yllcorner 4072345
cellsize 1
nodata_value -9999
43 3 45 7 3 56 2 5 23 65 34 6 32 etc
35 45 65 34 2 6 78 4 38 44 89 3 2 7 etc
etc

ESRI Binary Grid: The ESRI Binary file format is an ESRI proprietary format that contains the same cell values as the ASCII grid but these are stored in a binary format designed to load quickly in ESRI ArcGIS software.

Point Cloud LAS: The LAS point cloud containing all LIDAR returns and their attributes. Each point is assigned a classification code based on whether it is a ground point or a surface object. Surface objects are put into different classes based on the vertical distance to the nearest ground point.

5.0 Data Quality

The comparison against the ground truth surveys showed the accuracy of the data to be within 10cm which is considered of high quality. This indicates that although the data were acquired in large blocks and to long baselines this has not impacted greatly on the accuracy achieved. This height comparison is well within the stated accuracy of +/-25cm of the project specification.

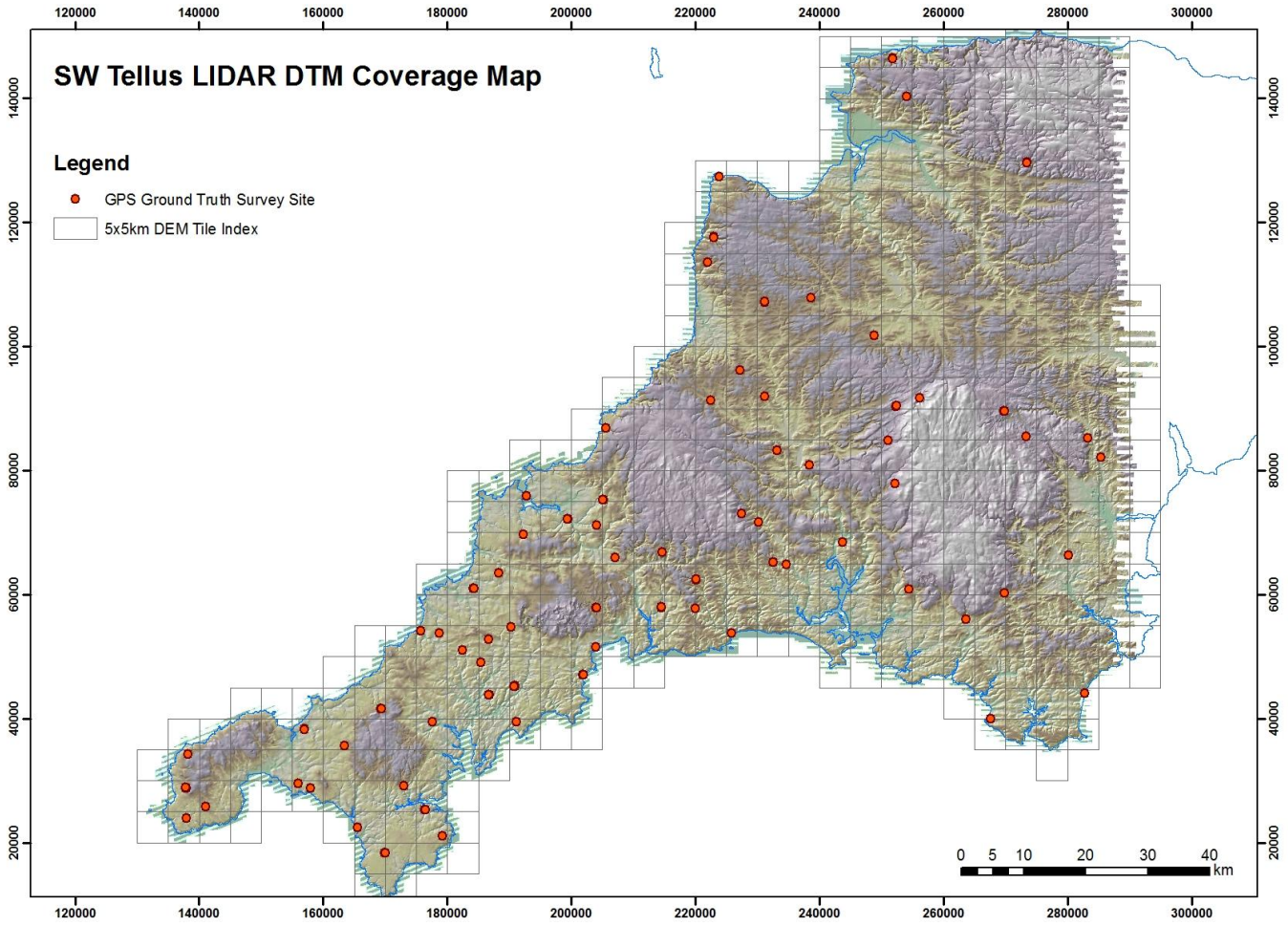
These comparisons are made in areas of no vegetation with limited slope and surface artefacts and so will not be indicative of the absolute height throughout the survey area.

The main quality factors to consider are:

The presence of vegetation in the data will mean that a false surface may have been derived in areas where the LIDAR pulse does not penetrate the vegetation canopy.

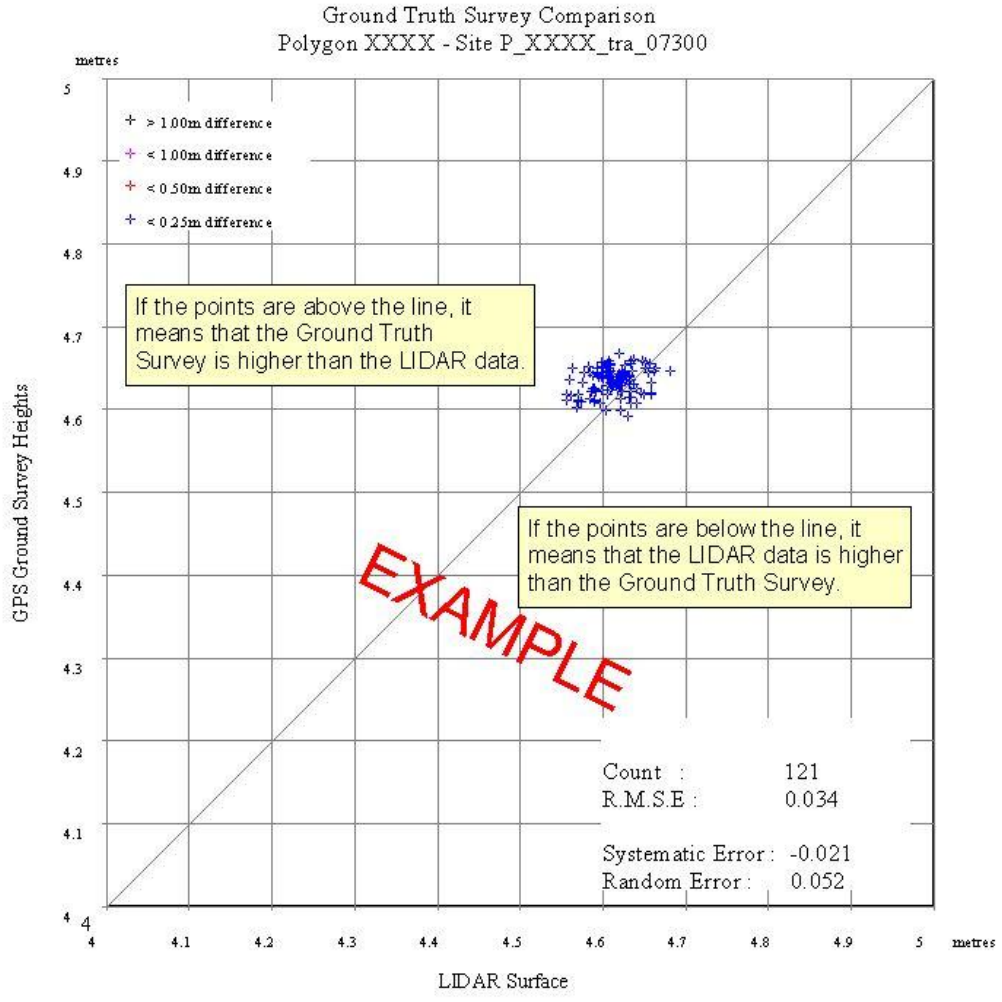
The automated routines may leave artefacts in the filtered product (the DTM) such as large buildings and bridges and may remove features that would have been retained with a more intensive filtering process.

Appendix A:


SW Tellus LIDAR DTM Coverage Map
Legend
GPS Ground Truth Survey Site
5x5km DEM Tile Index
0 5 10 20 30 40
km
120000
140000
160000
180000
200000
220000
240000
260000
280000
300000
20000
40000
60000
80000
100000
120000
140000

Appendix B:

Ground Truth Survey Comparison



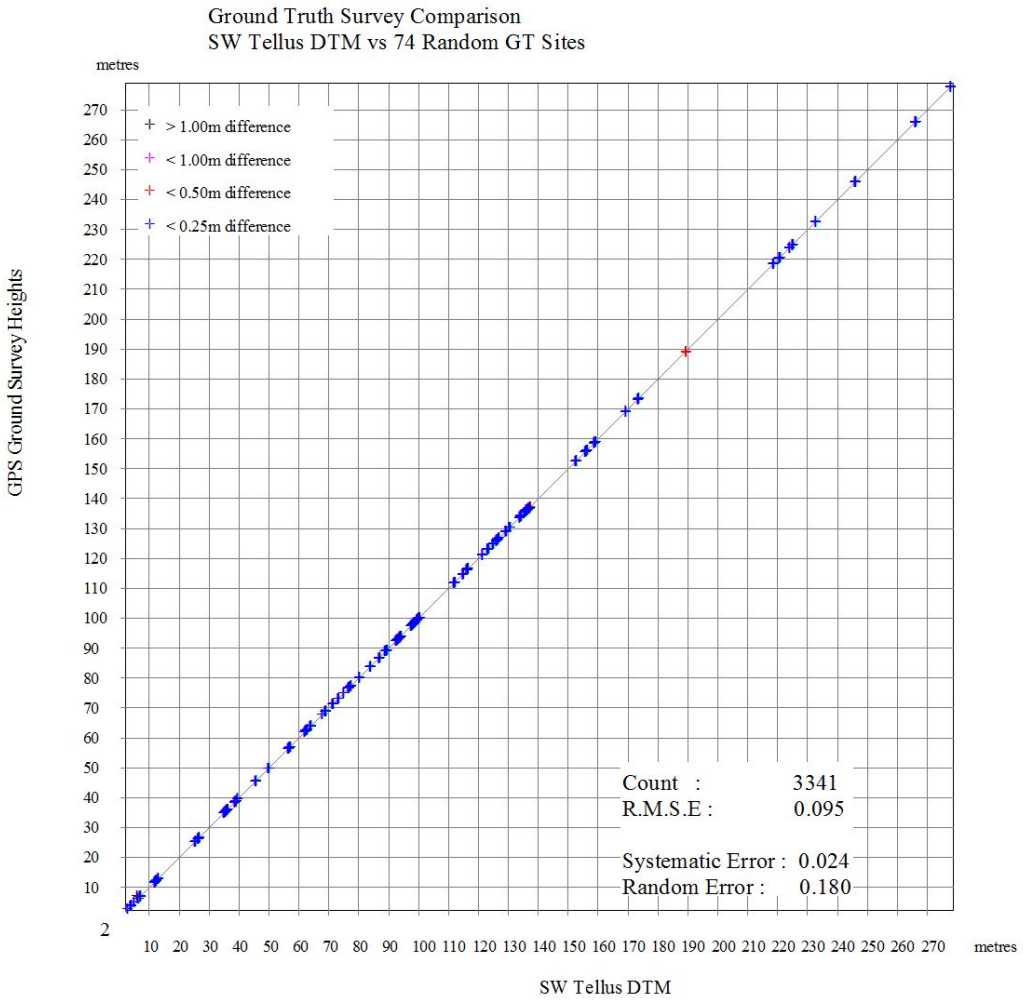
☑ Within accuracy specification

The root mean squared error or RMSE quantifies the error or difference between the Ground Truth Survey and the LIDAR Data.
Our specifications require the RMSE to be less than 0.15 (15cm).

Systematic errors are biases in measurement. For example, if the majority of the ground truth measurements were consistently above the LIDAR Data then a negative systematic error would occur.

Random error is always present in a measurement. It is caused by unpredictable fluctuations in the measurements. Random errors show up as different results for ostensibly the same repeated measurement.

Ground Truth Survey Comparison – Average of 74 sites



☑ Within accuracy specification