LANTMÄTERIET

2020-11-25

QUALITY DESCRIPTION

National Elevation Model

DOCUMENT VERSION: 1.5

Figure 1. Example National Elevation Model.

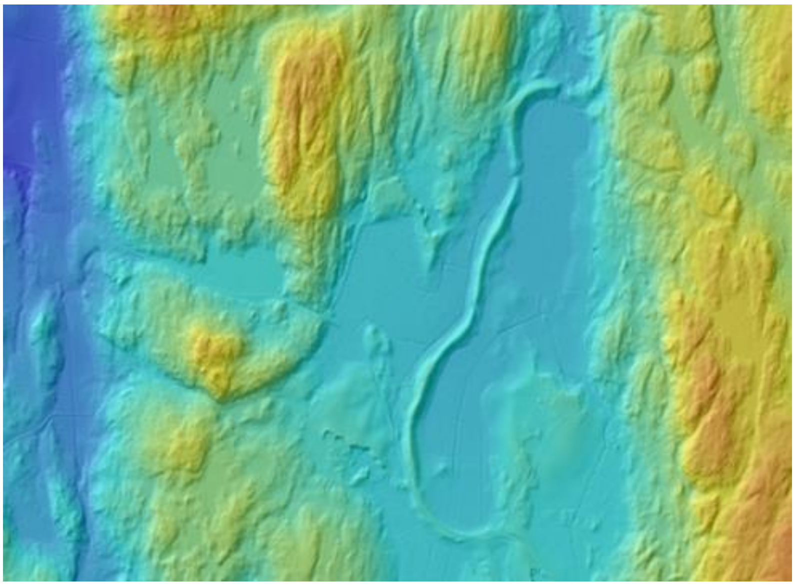
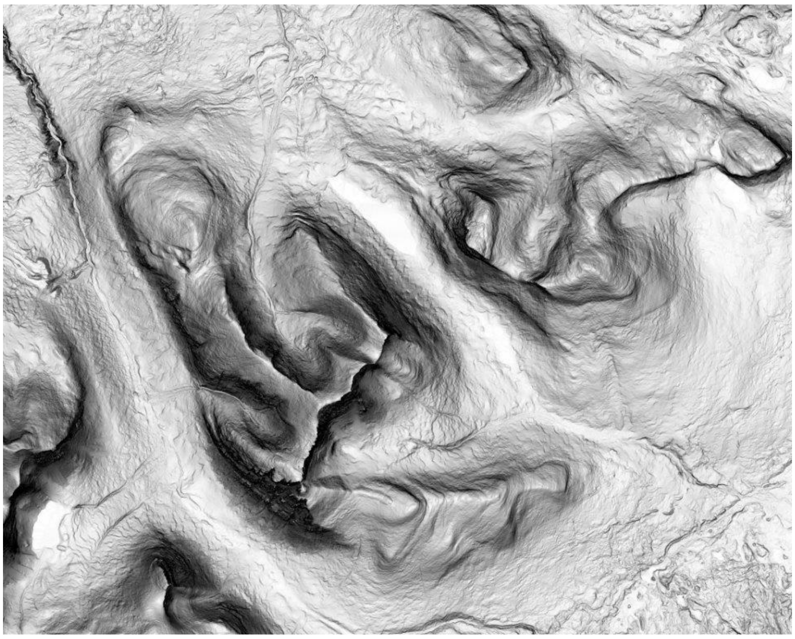


Figure 2. Example National Elevation Model.



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1 Introduction

This appendix describes the general quality of the National Elevation Model (a digital elevation model, DEM), and provides an overview of deficiencies that may exist.

The quality is presented using the quality parameters described in the Standard SS-EN ISO 19157:2013 Geographic information - Data quality.

The quality description applies to all product variants of the National Elevation Model as they are based on the same data.

Detailed quality description of laser data can be found in the document *Quality description of laser data* the websites Lantmäteriet - Laserdata NH and Lantmäteriet - Laserdata Skog.

2 General information about quality

The measured or estimated quality applies to the entirety of the whole scanning area. Since it is variation both within and between different scanning dates it is an estimated deviation indicated in the table below.

It is important to, for the area in question, refer to metadata such as survey technique, date for data capture and point density.
Good knowledge of the local terrain conditions is also valuable in the interpretation of data.

More detailed description of quality can be found in the text below.

Table 1. Quality themes and quality parameters. A more detailed description of origin, maintenance and quality can be found in the text.

Data quality element	Data quality subelement	Quality
Positional accuracy (RMS)	Terrain model (DTM) - Grid	**Aerial Laser scanning (LLS)** 0,1 m in height 0,3 m in plane **Aerial image matching (FBM)** Accuracy depends on image resolution, accuracy in height 1,5 times image resolution and in plane 1 times image resolution With image resolution 0,25 m 0,4 m in height 0,25 m in plane

3 Purpose and utility

The terrain model is counted as standard level 1 in HMK's (Swedish handbook in surveying and mapping, “Handbok i mät- och kartfrågor”) classification system. This means that the terrain model best suited to national and regional strategic planning.

The National Elevation Model has its origins in the need for data in order to be better able to assess the impact of climate change and implement climate adaptation strategies. But the National Elevation Model has also been used in a number of other areas of application, such as agriculture and forestry, emergency preparedness, planning, development, geology, archaeology and orienteering maps.

4 Data capture

Detailed description about data capture of laser data see the document *Quality description of laser data*.

A comprehensive terrain model in the form of a grid is created from laser points classified as ground and water. The calculation is done through linear interpolation in a TIN (Triangulated Irregular Network). This method conserves the terrain forms very well, but it is sensitive to single incorrect points that may have a great impact on the result.

Manually created points have also been used when creating terrain models using laser data with classification level 2 and higher. At many bridges, the point cloud is manually supplemented with points along the shoreline, or in some cases the underlying roadway, to achieve a good interpolation in the TIN. This is due to the fact that points are normally missing on the water surface and on the shore underneath the bridge.

In classification level 3 newly mapped shorelines are being gradually introduced as breaklines when classification to water in laser data which means that these water polygons have smooth and well-defined surfaces with a single height value (lakes, sea) or sloping surface (watercourses) in the terrain model. In laser data produced before year 2017 this has only been done for watercourses wider than 6 metres and lakes larger than 0.25 km^2, sea not included. In laser data produced year 2017 and after does this apply to most water polygons (sea, lakes, watercourse) but smaller watercourses are often missing.

4.1 Maintenance

Maintenance of the terrain model will be done with laser data or with aerial image.

Maintenance with laser data will be done with data captured for *Laserdata Skog*. Entire scanning areas will be updated with new data.

Small areas will be maintenance using a digital surface model created using aerial image matching. The terrain model is compared with digital surface model to identify elevation changes. The terrain model will then be updated with the most relevant changes (major elevation changes close to infrastructure or water) using aerial photos.

5 Quality description

More detailed quality description of laser data and an overview of deficiencies that may exist see the document *Quality description of laser data*.

5.1 Completeness (point density/coverage)

The point density on ground varies with terrain type, type of vegetation, the season during which laser scanning was performed and a number of other factors. This variation means that in some areas there are deficiencies in the point density, while in other places the point density is high.

The point density is presented in metadata for *Grid 1+*.

5.2 Classification

All omissions in the classification of laser data also appear in the terrain model.

Classification level is presented in metadata for *Grid 1+*.

5.3 Positional accuracy

Date for data capture, survey technique and positional accuracy is presented in metadata for *Grid 1+*.

The terrain model is created through linear interpolation in a TIN (Triangulated Irregular Network), with points classified as ground and water acting as nodes. In areas that lack ground points, interpolation can be done over large distances. See, for example Figure 1, where there is a lack of ground points and interpolation over a large distance must be carried out.

When using interpolation to create a terrain model in grid form, there is a certain impairment to the accuracy in elevation. The most significant decline is in very hilly terrain. Diminished accuracy during interpolation is related to the grid's resolution – the sparser the grid, the worse the quality is.

The quality in the terrain model also depends on and varies with the qualities and deficiencies in laser data – less accurate laser data results in the terrain model being less accurate.

Figure 3. Due to the dense vegetation, no laser points have reached the ground in the depression. The classification was accurate, but there is a shortage of ground points. When the terrain model is created, this surface will be interpolated. White points are unclassified, orange points are ground.

The terrain model's water surfaces may have distorting artefacts from the interpolation, despite the laser points having a high level of accuracy in elevation. As the terrain model is produced using linear interpolation in a TIN, very elongated triangles may be formed between the shoreline and the nearest point on the water surface (Figure 4). There are no laser points present within these triangles, and if there are no ground points close to the water surface, the interpolated elevation may differ significantly from the water surface's actual elevation.

From classification level 3, this problem does not persist for most of the water surface as these water surfaces have been smoothed. However, this may instead give rise to elevation steps if a water surface has been scanned at different times and the water level has varied (Figure 5).

Figure 4. After using interpolation to create a terrain model in grid form, triangles connect to points on the water surface or, in some cases, to points on the opposite shoreline.

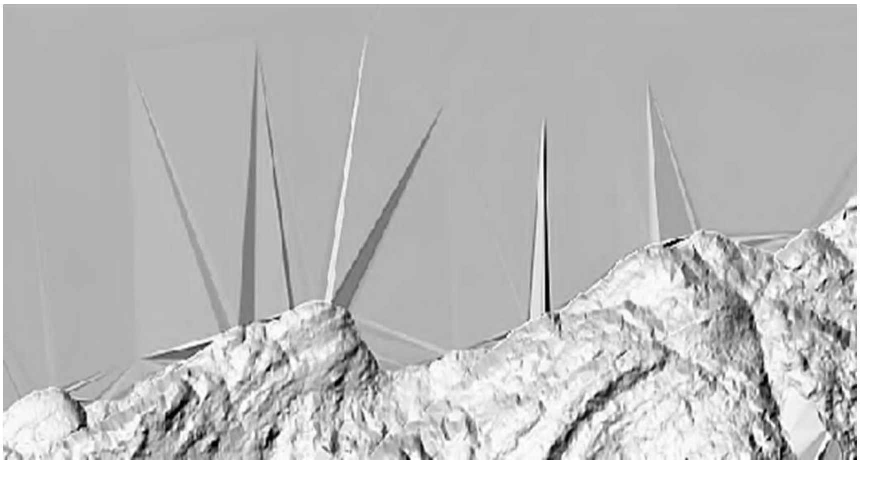
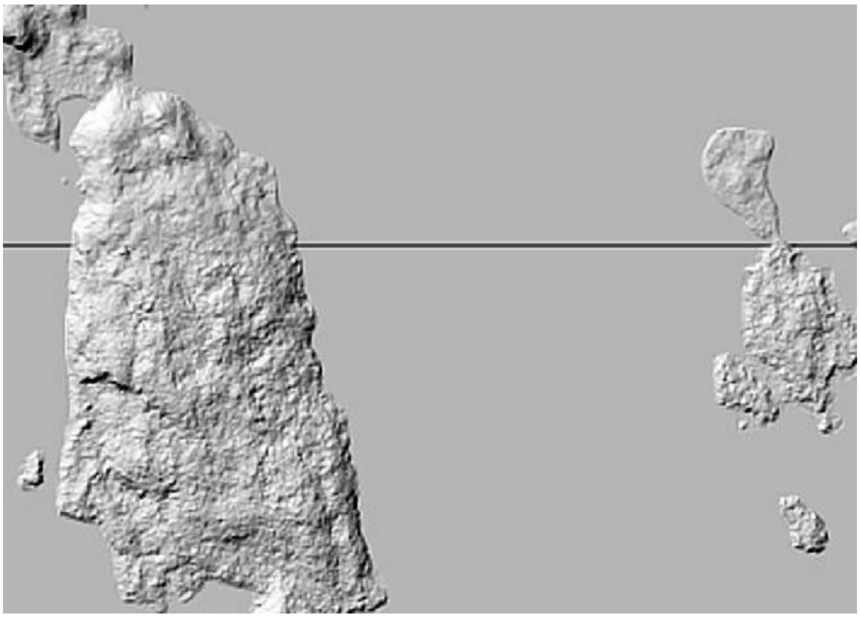


Figure 5. Elevation step if a water surface has been scanned at different times, the water surface north of the line has a water level 50 cm higher at the scanning occasion.



6 List of changes

Table 2. List of changes.

Version	Date	Reason and change from previous version
1.5	2020-11-25	Update section 5 with Grid 1+ and clarify section 2, estimated deviation
1.4	2019-08-20	Supplemented with Figure 5.
1.3	2019-06-11	Detailed quality description of laser data now in the freestanding document *Quality description of laser data.* Add reference to *Quality description of laser data* and some adjustment in the text because of that. Update section 5, maintenance with laser data.
1.2	2019-02-26	Information about maintenance terrain model in chapter 5.
1.1	2016-12-01	The document is no longer an appendix but a freestanding quality description for all the national elevation model products. Some adjustments have been made to the text because of that. This list of changes and version number have been added to the document. Information about number of returns have been adjusted in chapter 3. Misleading information of accuracy has been adjusted in the table of quality and chapter 4.3.3. Note that there are no changes in the data itself or the estimation of the quality. Some adjustment to text regarding classification levels in chapter 4.2 and 4.3, due to progress in production.
Appendix B	2015-10-01	Existed in the form of Appendix B to the product descriptions for Laser data and Grid 50+.