KOMPENDIUM

Setting up and using QGIS for geomorphological exercises

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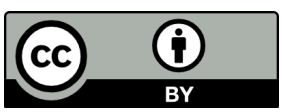


Preface

This instruction shows how you download and install QGIS as well as add some necessary plugins to use in conjunction with the compendium Övningar i geomorfologi/Exercises in geomorphology. This is not a complete tutorial on how to use QGIS, nor an introduction to GIS, but will set you up to use QGIS for working with digital elevation model data.

If you wish to explore the data of the exercises further you should resort to the wealth of online information given through the QGIS documentation site and the StackExchange GIS Q&A site.

In your continued education you may encounter ArcGIS which is a commercial GIS software. QGIS is freeware and always available to you and therefore a useful software to have in your toolbox. The way you process data may vary in detail between the two but general GIS principles are the same. I suggest you always keep your eyes on Open Source software since such software is built by the community that uses it.

Note that you can install QGIS on all platforms, Linux, Macintosh and Windows. You can also keep several versions installed at the same time. QGIS maintains what they call a 'long term release' (3.16.13 at the time of writing) at the same time as their 'latest release' (3.22.0 at the time of writing). The long term version should be very stable whereas the latest version may include novel solutions but not be stable under all circumstances. I would recommend that you start with the stable version and install the new version if you think you need it. I can only add that I have so far never experienced problems with the latest release versions. The versions are similar but availability of plug-ins may vary.

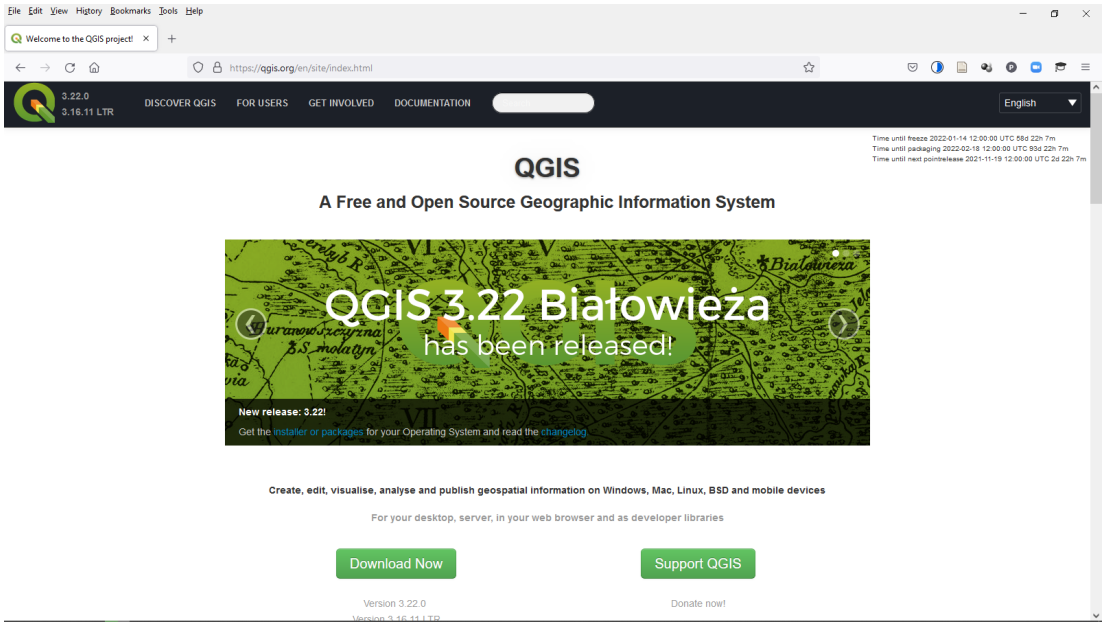
In this introduction, figures may show slightly different views than what you see in your installation. This may be because slight changes have been made in recent updates or that personal settings made by me in my installation come across.

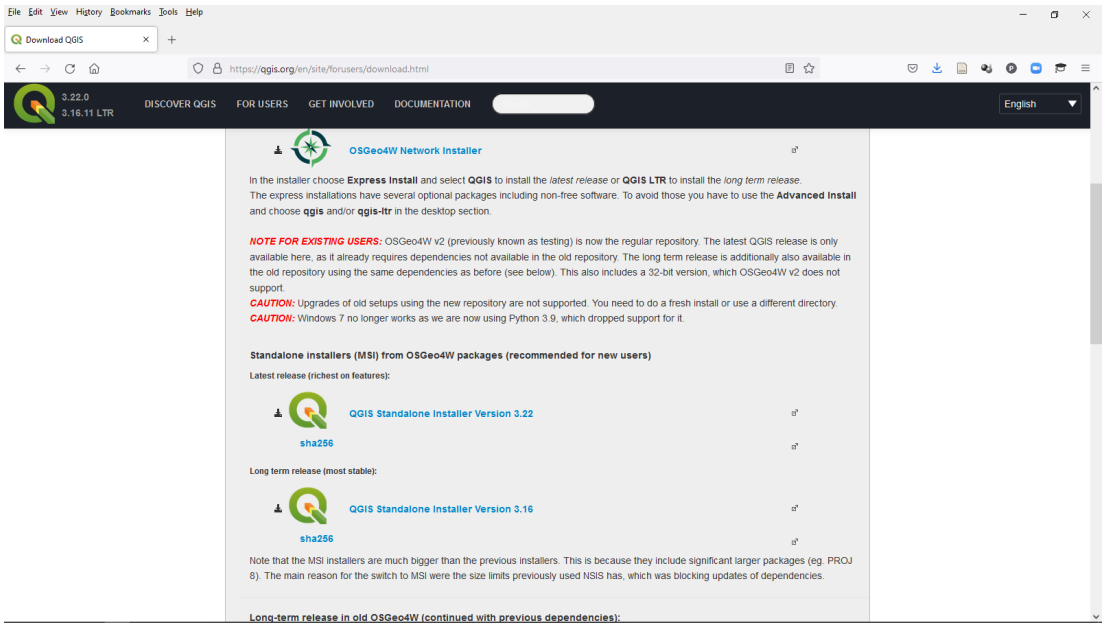
This instruction was written using LaTeX in Overleaf and figures prepared in GIMP (GNU Image Manipulation Program) and Inkscape.

Support Open Source freeware!

1 Installing QGIS

To install QGIS visit the QGIS web site and download the 'Long term release' or 'Latest release' 32 or 64-bit QGIS Standalone installer that fits your system.





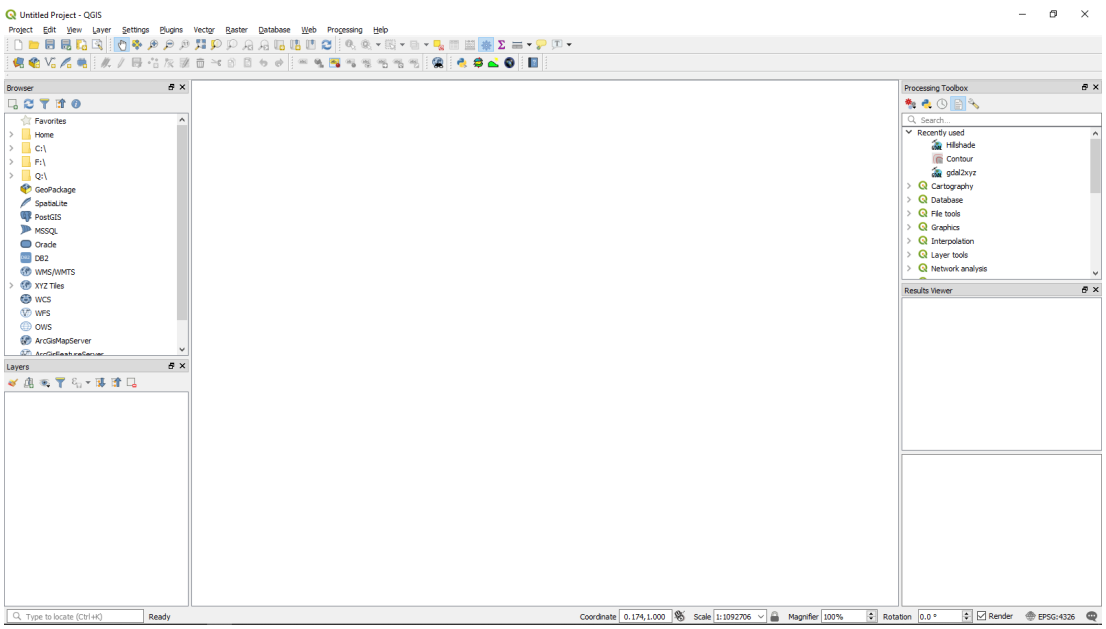
Once the installation file is downloaded run the file and accept the default settings presented to you. Once the installer has complete the process you have a fully functional free and open GIS system on your computer[1].

[1] Macintosh installations may require additional steps, please read the installation instructions for further information

2 The graphical user interface

Once you have installed QGIS you will note that several programs seem to have been installed. For now you only need to concern yourself with the 'QGIS Desktop', which is what we will use.

Start QGIS by clicking on the QGIS Desktop icon. This will open a window looking like the following image



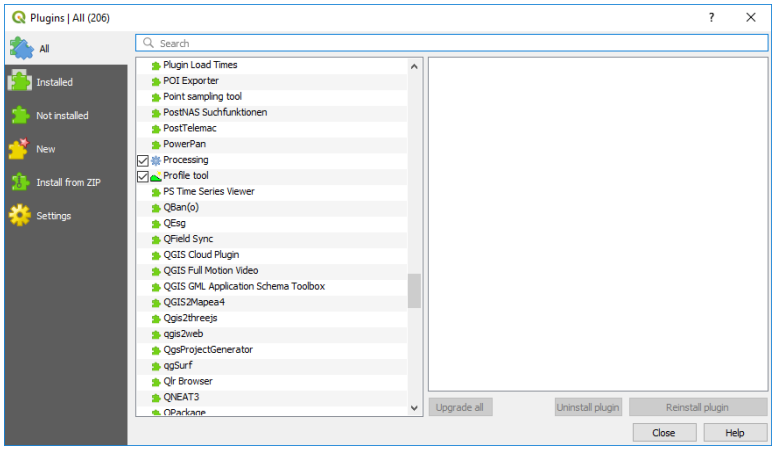
There are several panes in this window. The largest is the map window where your work will be shown. To the left you will see two panes called 'Browser' and 'Layers'. The browser pane shows files and folders in your GIS project and the layers pane shows the different layers of data in your project. We will see this in detail below. To the right you see two panes called 'Processing Toolbox' and 'Results Viewer'. We will also return to these later.

There are lots of tools in toolbars and menus and for the time being you should not concern yourself too much with these. We will return to everything you need when you need it.

3 Additional tools

QGIS provide means to use a large number of specialised tools provided as so-called 'plug-ins'. For the geomorphological exercises you will need to install a plug-in called 'Profile tool' which allows you to view elevation profiles in the DEMs you will be working with.

To install this plug-in, you click on the plugins menu item and select the Manage and Install Plugins…. This opens a new window which lists all available plugins. Locate the 'Profile tool' plugin entry in the list.



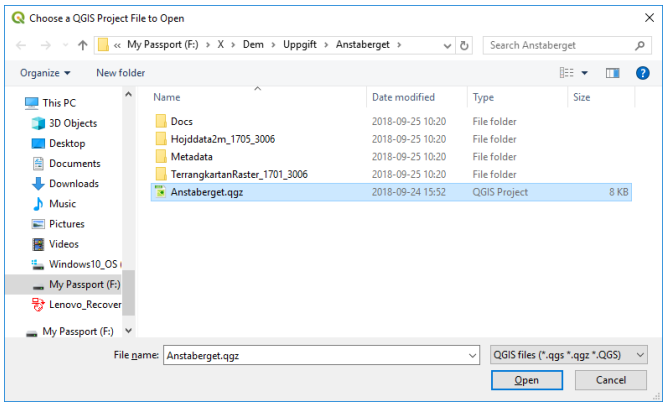
Click on the plugin name and click on the Install plugin button that appears at the lower right in the window. The plugin will be installed and marked with a checked box to indicate it is installed. You will also find the Profile tool as an icon in the tool bar.

You should now have all the necessary tools you need for the exercises.

4 Open a GIS project

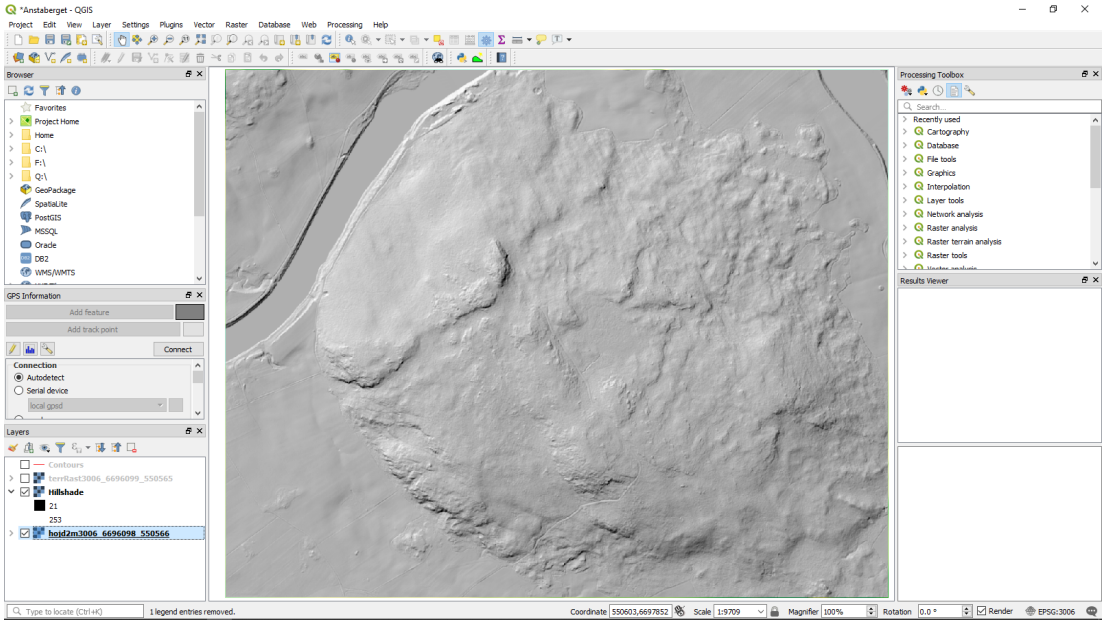
The geomorphological exercises come as already prepared QGIS projects. When you download a project you will receive it as a Zip-file. Simply unzip the content to some folder where you keep data. Each project will unzip as a folder with a name indicating the locality of the GIS project. So when you download several projects and unzip them in the same basic folder the different files will still be contained in a separate sub-folder.

In each project folder you will find a QGIS project file with the extension `qgz`[2]. To open a project simply click Project in the QGIS menu followed by Open and locate the `.qgz` project file.



In the figure we have a project file called `Anstaberget.qgz`. Open the project file and you will see the project in your main pane of QGIS:

[2] `.qgz` is a zipped file. In older versions of QGIS the project file had the extension `.qgs`. In more recent versions of QGIS both types can be opened whereas older versions can only open `.qgs` files. The recent version can save projects in both formats.

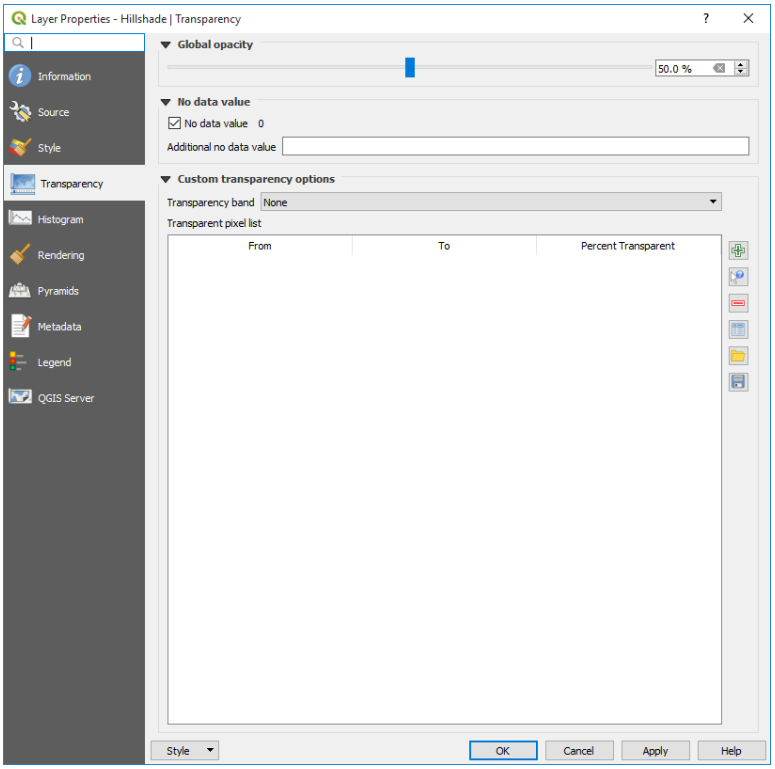


The project now displays in the main pane. In the lower left pane you see (in this case) four entries, two of which are ticked boxes and two that have empty boxes. Each box and explanatory text concern a layer in your project. This project has four layers which you can think of as four sheets of paper stacked on top of each other, each containing some information. You can turn each layer on or off by checking (clicking) or unchecking the box. In the case above the lower two layers are checked which means the upper two are invisible at this point.

The layer names may be difficult to understand. The names can be changed but in these projects some layers have been left with the original names of the data. The layer starting with 'hojd2m3006...' is the 2-m resolution elevation data obtained from the Swedish Land Survey. The layer called 'Hillshade' contains the shaded relief that you see in the figure. The layer starting with 'terrRast2006...' is a terrain raster map also obtained from the Land Survey. The 'Contours' layer contains the elevation contours calculated in QGIS from the elevation data. We will return to these layers later.

You can select and unselect these layers to view or hide each layer. But, remember, you can only view a particular layer if layers above are first turned off, otherwise they may obscure the layer you wish to look at. It is possible to make layers translucent but we will return to this below.

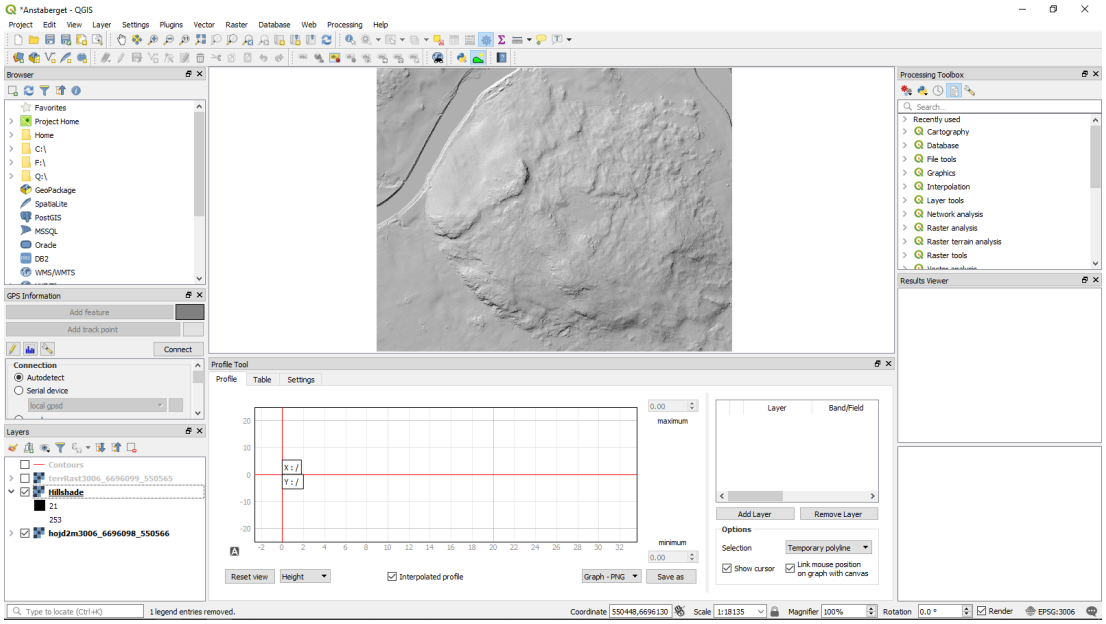
If you mark a layer by clicking on it in the layers pane and right click on the layer you will see a menu where one entry is called 'Properties'. Selecting this opens a window where you can make many changes to that layer



The content of the properties window will differ depending on what type of layer you are working on. One setting you can see to the left is 'Transparency'. In this setting you can change the setting for your layer from 'opaque' (default) to some percentage of transparency. This means you can set a layer so that you can see through it and hence see the layer below to some extent. Give it a try, you can always reset it to opaque (100% opacity).

5 Using the profile tool

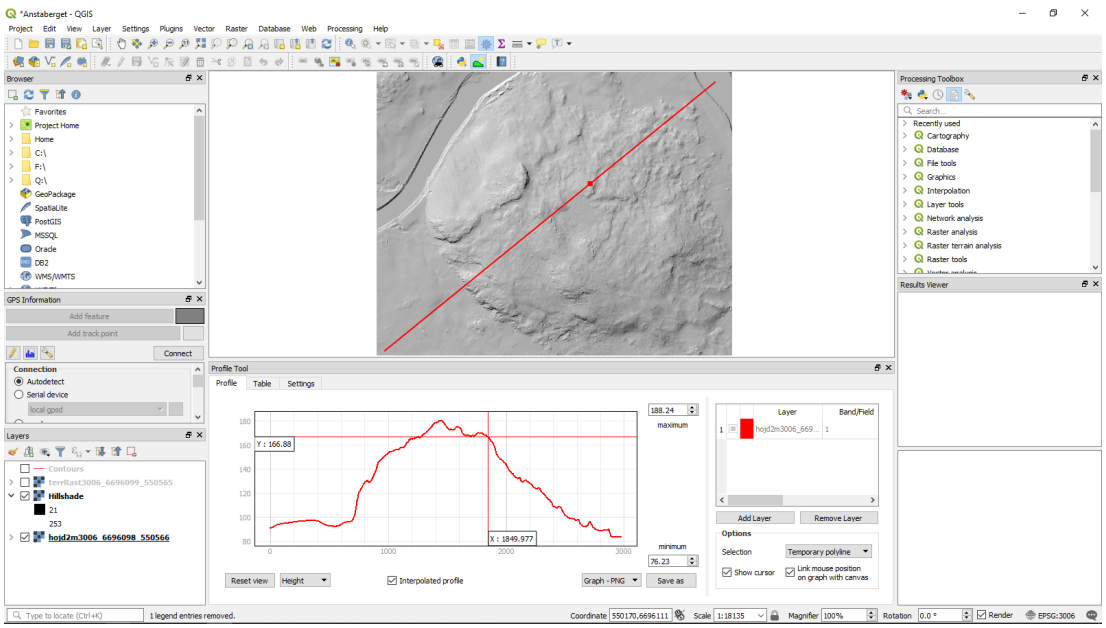
When you want to measure a profile in your terrain data, you need to click on Plugin and then select the Profile tool followed by Terrain profile or click on the profile tool icon in the toolbar. This opens a new pane below the main map pane



In this example we want to make a profile across the hill from the bottom left to the top right corner of the map. Note that when you opened the profile tool the map was shrunk so that you see just as much of the map as you did before.

Start by clicking on the terrain data in the 'Layers' pane. Then click on the Add layer Button in the profile tool. The elevation data you selected in the layers pane will now be included in the profile tool. You are now ready to make a profile.

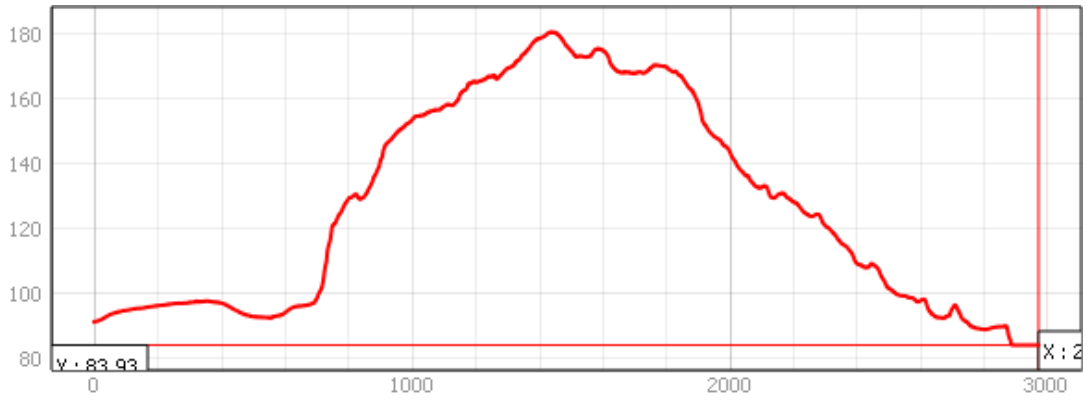
To create a profile you click once on the map where you want your profile to start and then move the cursor to the point where you want the profile to end and double click. This establishes a straight line profile between the start and end point. As you double click to end the profile the profile will be visualised in the profile graph.



Note that the profile in the graph window is plotted from left to right as you started and stopped your profile. In this case I started the profile in the lower left corner and finished in the upper right corner so that the plotted profile depicts the general direction

of the profile in the map.

Once you have made a profile you can export the graph to a file. You have the option to chose a PNG bitmap graphics file, a SVG vector graphics file or a DXF CAD file. The simplest choice is to use the PNG option which yields a figure you can quickly save for additional study. The following figure was exported from the profile tool as a PNG graphics file:



Since the elevation model is measured in metres, the vertical and horizontal scales are in metres. The vertical is given as m a.s.l. (metre above sea level; the elevation) whereas the horizontal is given as metres from the starting point (0).

If you look at the Profile tool above you can see that there are two straight red lines in the graph window, one vertical and one horizontal. These lines move as you move the mouse cursor over the plot window. When you do so there will be a red square moving along the profile line in the map view. This means you can identify exactly what part of the profile is where on the map, or *vice verse*. You can also immediately see the values extracted from the DEM along the profile which means you can check, for example, elevation differences between two points along the profile.

The profile you established by clicking on the map is not permanent. If you click on the map again you establish a new starting point for a new profile and the previous profile will be lost. If you want a profile that is not a single straight line, you can make line segments by single clicking on a series of points creating shorter strait segments between the points. You still finish the profile by double clicking on the desired end point of the profile.

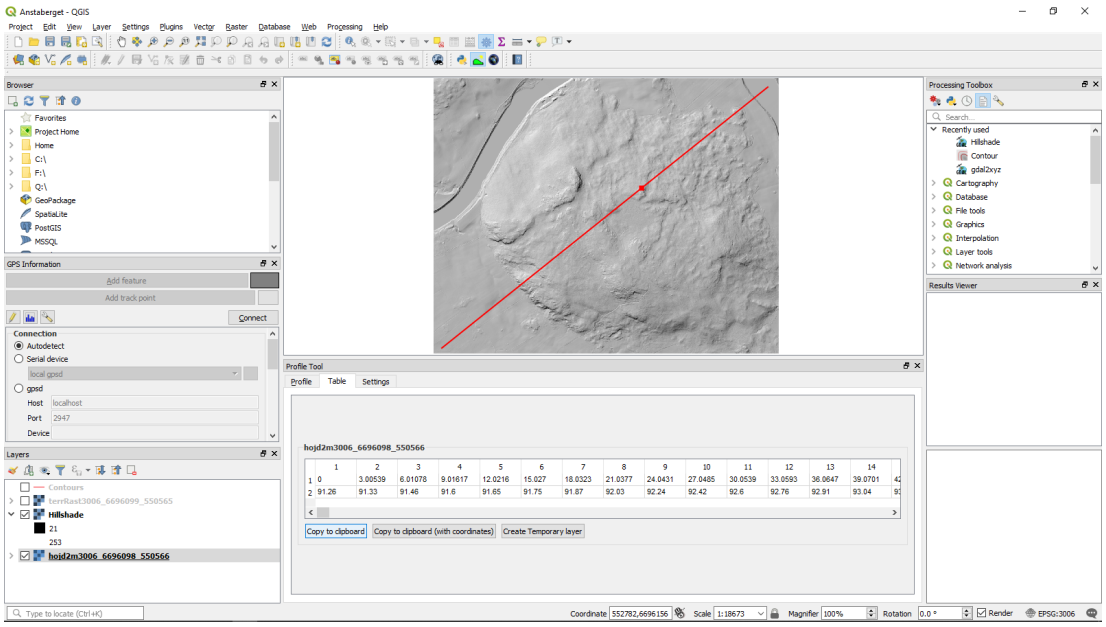
It is important to realise that the plot window will adapt to the maximum and minimum values of the profile. Hence you need to be careful when comparing two profiles since the vertical scale may vary between the two. The tool is nevertheless a very useful tool for quickly examining and evaluating what the DEM shows.

Note that we have used the elevation data for the profile in this example but used the 'Hillshade' to view the topography. The reason for viewing the hill shade is that it provides a better 'feel' for the topographic changes that the pure elevation model. So do not forget what it is you are doing and what you see. A common mistake is to draw a profile but using the wrong layer as a source which will yield confusing results.

Once you close the profile tool window all profiles will be lost. You do, however, have the possibility to copy the profile data from QGIS to, for example, a spreadsheet software such as Excel or or Openoffice Calc. In the following we will look at how to transfer data to Excel.

If you click on the 'Table' tab in the profile tool pane, you will see the data that

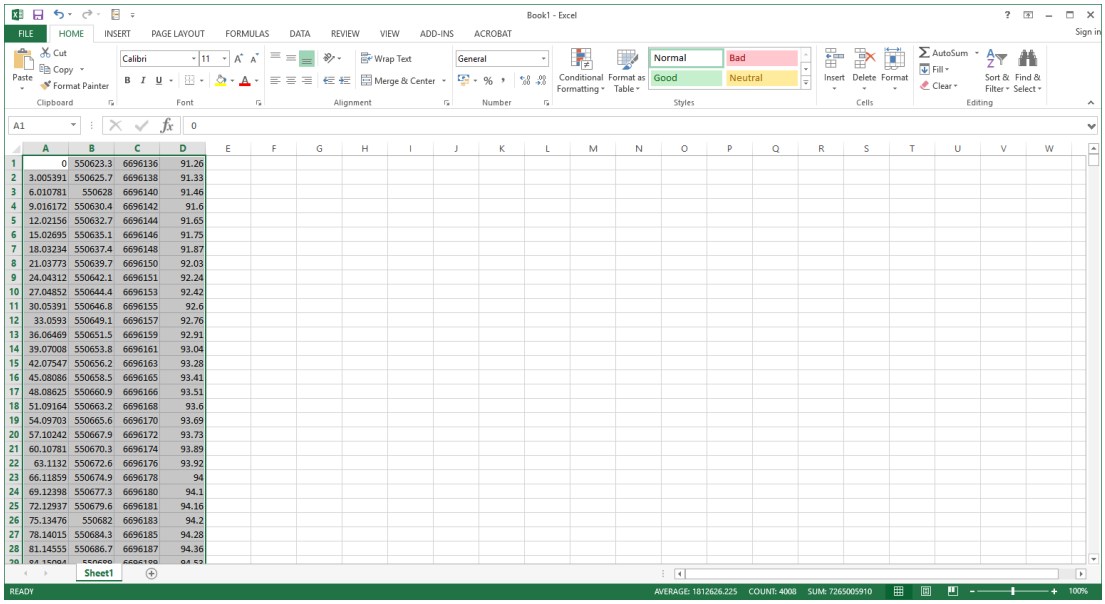
makes up the profile. The data is distance along the profile and the elevation at each point. This is what makes up the profile in the profile view above. The data that is extracted along the profile consist of a maximum of 1000 equally spaced points. It is possible to obtain more data points by checking a box titled 'Full resolution enabled' on the 'Settings' tab. This will provide data that matches the full resolution of the elevation data (2 m). This may be necessary if profiles become very long so that the resolution with a 1000 points is deemed too poor. Remember, however, that, say, a 1 km profile sampled at 2-m resolution will yield 500 data points. This will allow you to estimate how many data points will be obtained for a specific profile length you intend to store.



Below the the data you see three options for copying this data. The first copies the distance and elevation data so that you can paste it into a spreadsheet like Excel. The second does the same but also provide coordinates for each point. This may be useful since it will tell you where the terrain profile is located. Since it is also possible to make profiles that are not a single straight line, coordinates may be even more useful to store. The third option creates a temporary layer showing the points and the profile in your GIS project. The layer will contain all the points that the profile tool extracted.

The temporary layer created by the Profile tool is just that, temporary. If you save your QGIS project and reopen it the layer will exist but the information in the layer will be lost. In order to save the profile you can right-click on the temporary layer after it has been created and select 'Save as...'. Give the layer file a name and by default the layer will be named the same. Now your profile has been saved. Note that you will now see both the temporary layer and the copy you saved. You can safely delete the temporary layer and next time you open the project your saved layer will be included showing the profile points.

It is useful to be able to extract profile data to draw a better diagram of the data than what the profile tool can do. When you have copied the data using, for example, the incl coordinate button you should be able to paste straight into an Excel spreadsheet. The spreadsheet will look like this:

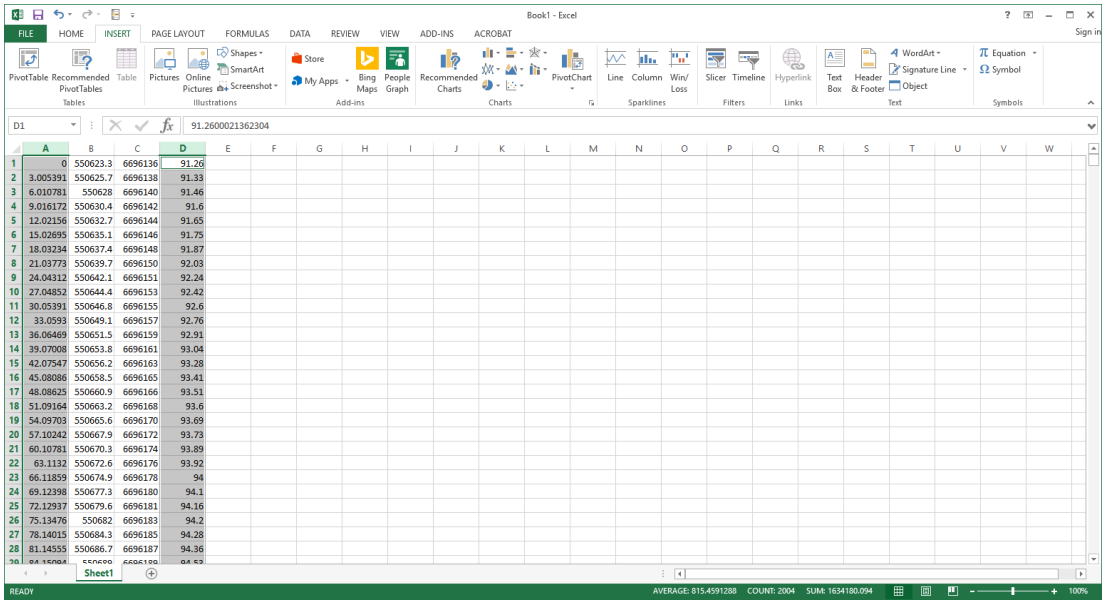


	A	B	C	D
1	0	550623.3	6696136	91.26
2	3.005391	550625.7	6696138	91.33
3	6.010781	550628	6696140	91.46
4	9.016172	550630.4	6696142	91.6
5	12.02156	550632.7	6696144	91.65
6	15.02695	550635.1	6696146	91.75
7	18.03234	550637.4	6696148	91.87
8	21.03773	550639.7	6696150	92.03
9	24.04312	550642.1	6696151	92.24
10	27.04852	550644.4	6696153	92.42
11	30.05391	550646.8	6696155	92.6
12	33.0593	550649.1	6696157	92.76
13	36.06469	550651.5	6696159	92.91
14	39.07008	550653.8	6696161	93.04
15	42.07547	550656.2	6696163	93.28
16	45.08086	550658.5	6696165	93.41
17	48.08625	550660.9	6696166	93.51
18	51.09164	550663.2	6696168	93.6
19	54.09703	550665.6	6696170	93.69
20	57.10242	550667.9	6696172	93.73
21	60.10781	550670.3	6696174	93.89
22	63.1132	550672.6	6696176	93.92
23	66.11859	550674.9	6696178	94
24	69.12398	550677.3	6696180	94.1
25	72.12937	550679.6	6696181	94.16
26	75.13476	550682	6696183	94.2
27	78.14015	550684.3	6696185	94.28
28	81.14555	550686.7	6696187	94.36

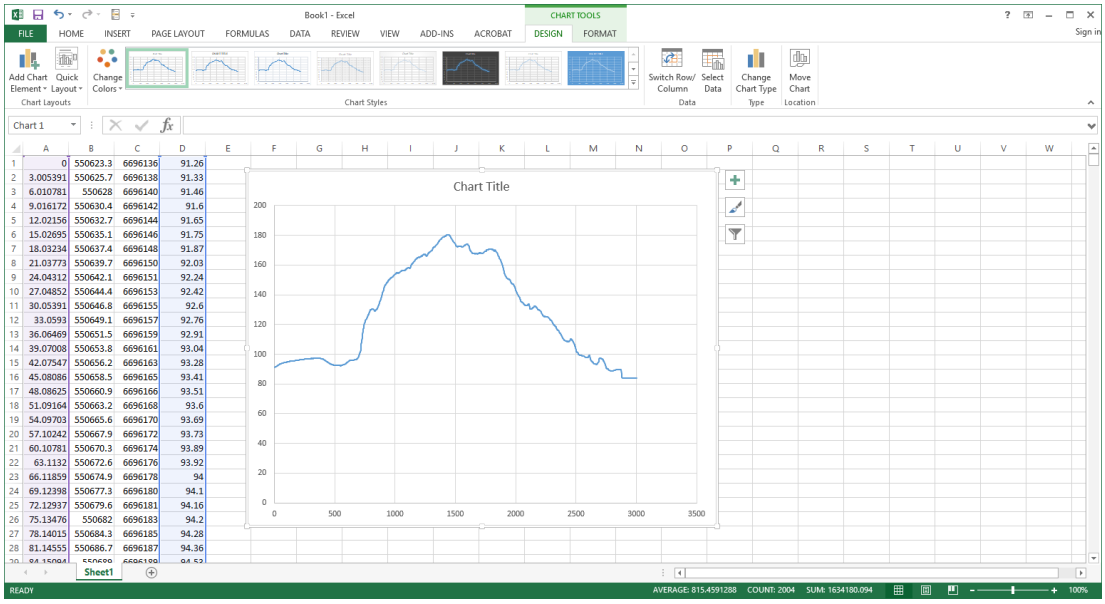
As you can see you receive four columns of data, the first is the distance along the profile, the second and third is the coordinate pair for the point and the fourth column shows the elevation of the point. The coordinates are in Sweref 99 TM with elevations in the RH 2000 model. You can find more information on these systems for reporting elevation data at the Swedish Land Survey (Lantmäteriet) web site.

One issue that you may encounter is that the data you obtain from QGIS will have period (.) as decimal point whereas in many European countries comma (,) is used. Period has become a standard in programming and hence many software that handle data. When you paste data into Excel you can experience that the numbers with period as decimal point are treated as text and not a number which means you cannot make any calculations with the data and, in our case more importantly, make a diagram of the data. The problem, if it occurs, can easily be remedied by doing a 'find and replace' in Excel where you find all points and replace them with commas. Then the data should be considered numbers again by Excel.

Once you have your data in Excel, it is time to create a diagram of the data. We want to plot the profile using the distance (first column) and elevation (fourth column) data. Mark the first column and then mark the fourth column while pressing the Ctrl-button. The two columns should now be marked as shown below

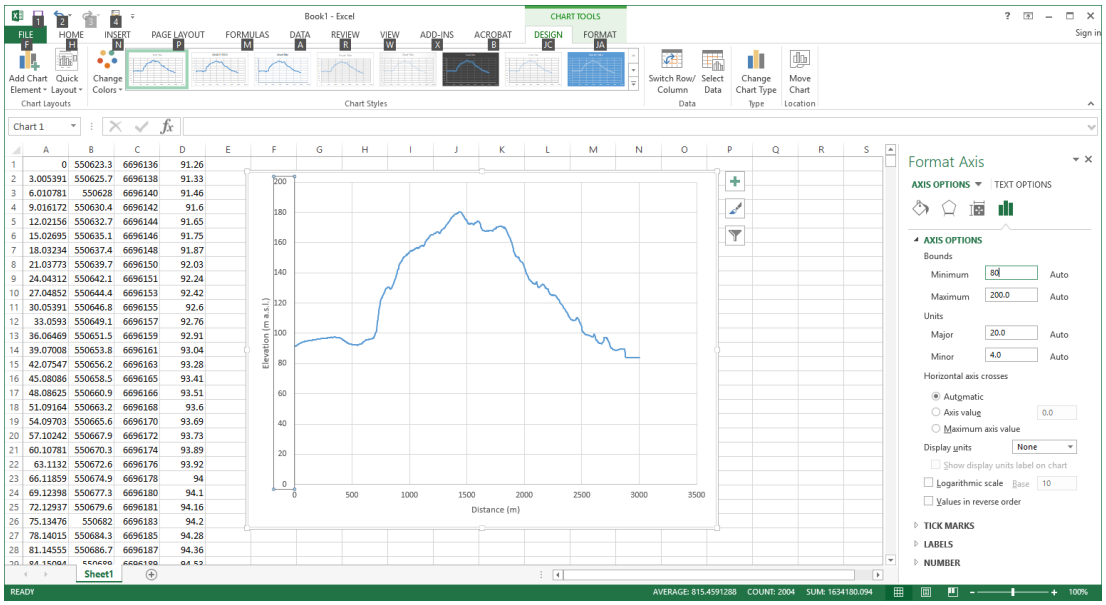


Select the ‘Insert’ tab and select the scatter plot as the type of chart. You then have several options for the type of scatter plot to make and you should chose the option with straight line segments and no markings for the data points. This will create a clean plot of the profile.

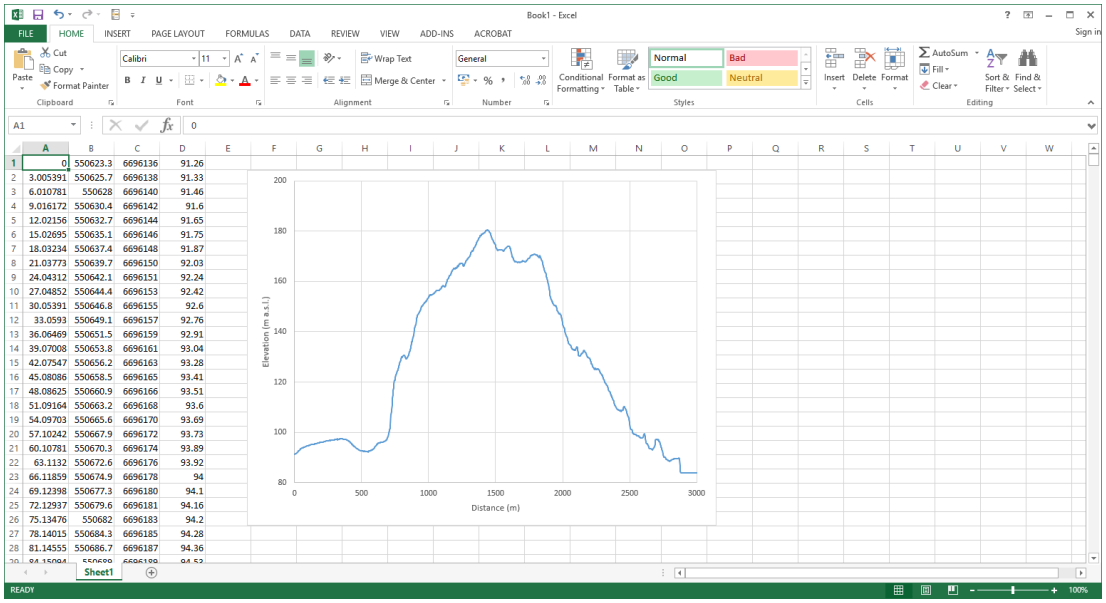


As you see from the picture above, the plot we receive is not yet in shape, some more work is needed. First we need to add titles to the axes. All plots MUST have axis titles that tell us what is being plotted and what units are shown on the axis. Click on the ‘Add Chart Element’ and select ‘Axis titles’. You then have the option to add a label to either the horizontal or vertical axis and you of course need to edit both. In our case we add the x-axis title ‘Distance (m)’ and the y-axis title ‘Elevation (m a.s.l.)’. The m a.s.l. means ‘metres above sea level’ and is the normal way to express elevations. In Swedish this is written m ö.h., ‘meter över havet’. Note how you punctuate the abbreviations. The SI unit ‘metre’ is abbreviated ‘m’ without a period while the ordinary words are abbreviated with a period. Units are never followed by periods.

Secondly we can see above that the axis are not optimal. There is a lot of dead space below the profile and also to the right where the profile ends. We should thus change the limits for the axes from the default values to something that better reflects the data. Simply double click on the one axis to open the 'Format axis' pane as you see below. Enter the desired max and min values for the axis in this case I wanted the y-axis to start at 80 m and stop at 200. Note that I have chosen even numbers. This is usually a good approach. Once you have completed the y-axis you can do a similar change on the x-axis.



When you are done you have an acceptable chart showing the profile you extracted from the DEM. When you write a report you can safely include this diagram in the report. All diagrams you make and provide in reports must have the features we have edited, axis titles and axis ranges that shows the data properly.

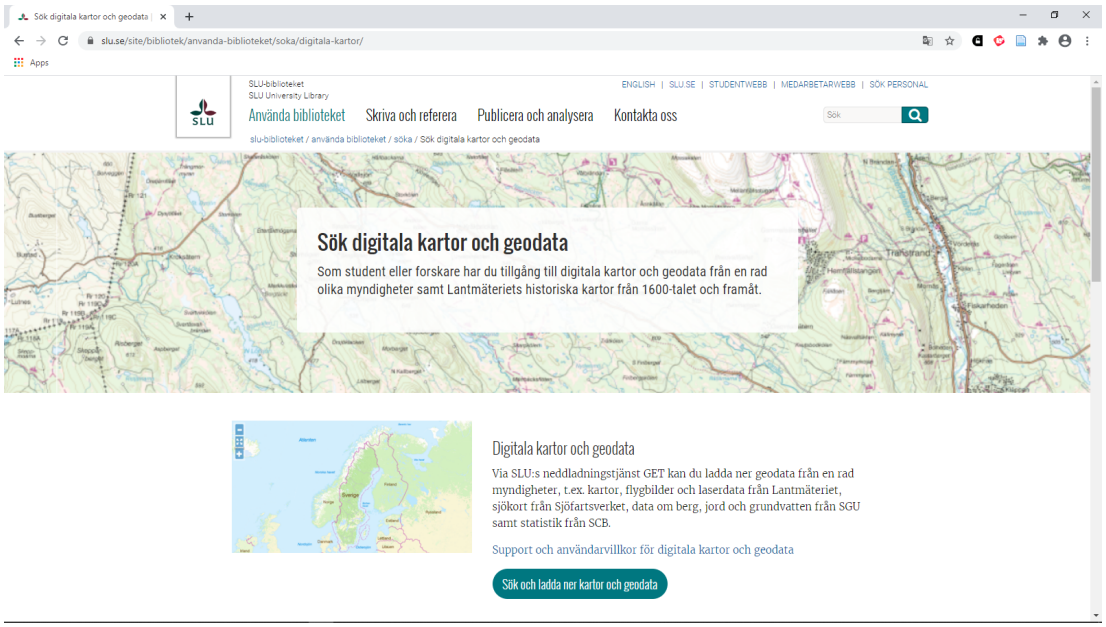


6 Downloading and working with your own terrain data

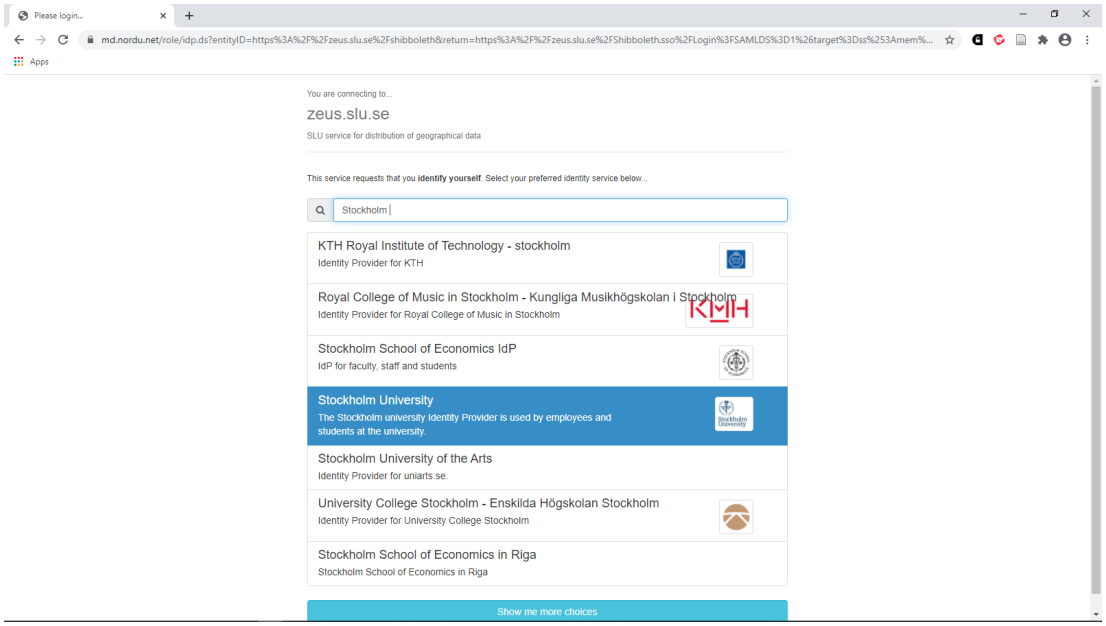
The Digital maps and geodata site run by the Swedish Agricultural University (SLU) provides many different types of data including elevation data, othophotos, and terrain maps. Data comes in one of two formats, raster and vector based data. Much of the raster data comes in *tiles*, i.e. the data set has been split into square pieces. These tiles cover 2.5×2.5 km. However, some raster data will be delivered in tiles of different sizes and all vector data will be provided as one continuous data set covering the area you have outlined in your data request. We will now look at how the data is downloaded and what it looks like.

6.1 Selecting and downloading data

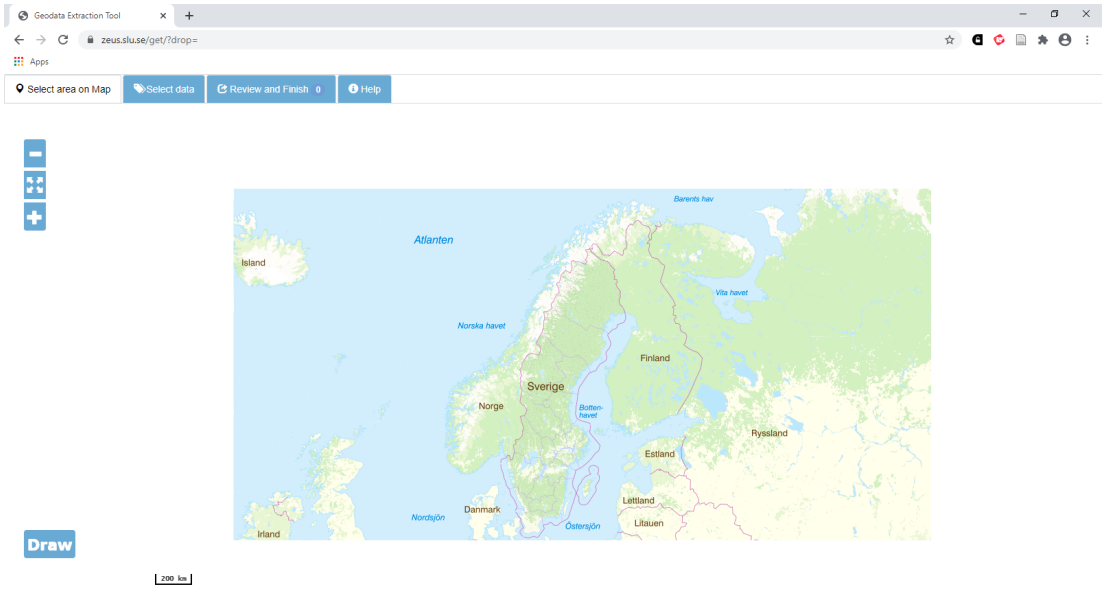
The SLU site Digital maps and geodata is available in both Swedish and English.



To start downloading data on the blue ‘Search and download maps and geodata’ field. You will then be asked to identify your affiliation in a long list of choices. Select ‘Stockholm University’ which will yield the following screen:



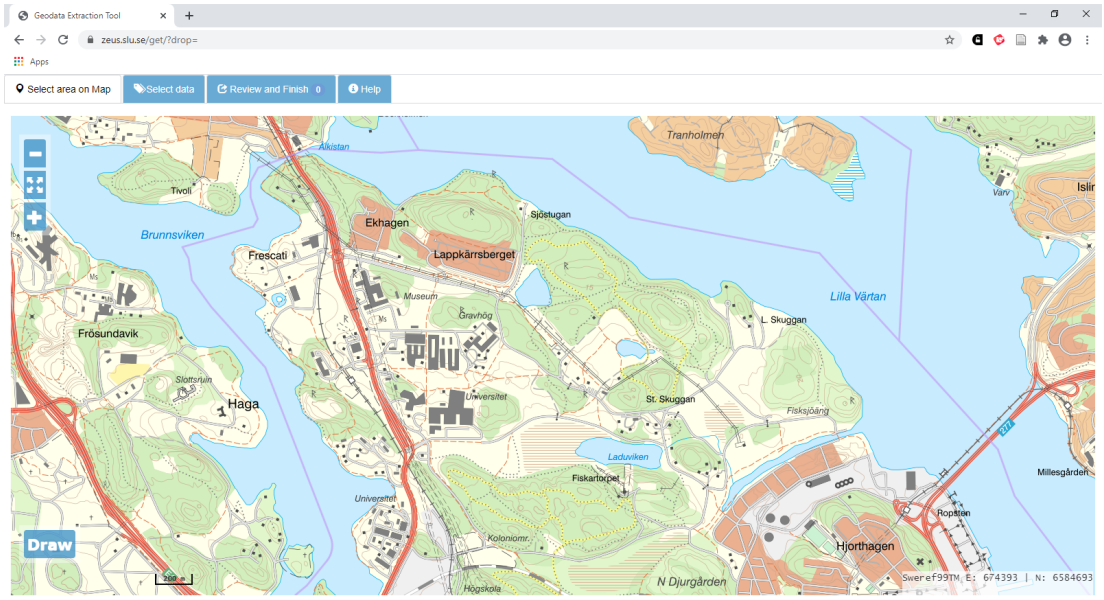
Click on 'Proceed to Login'. A new screen will open where you provide your Stockholm University login details. Once you have completed the login a new screen will open with an overview map:



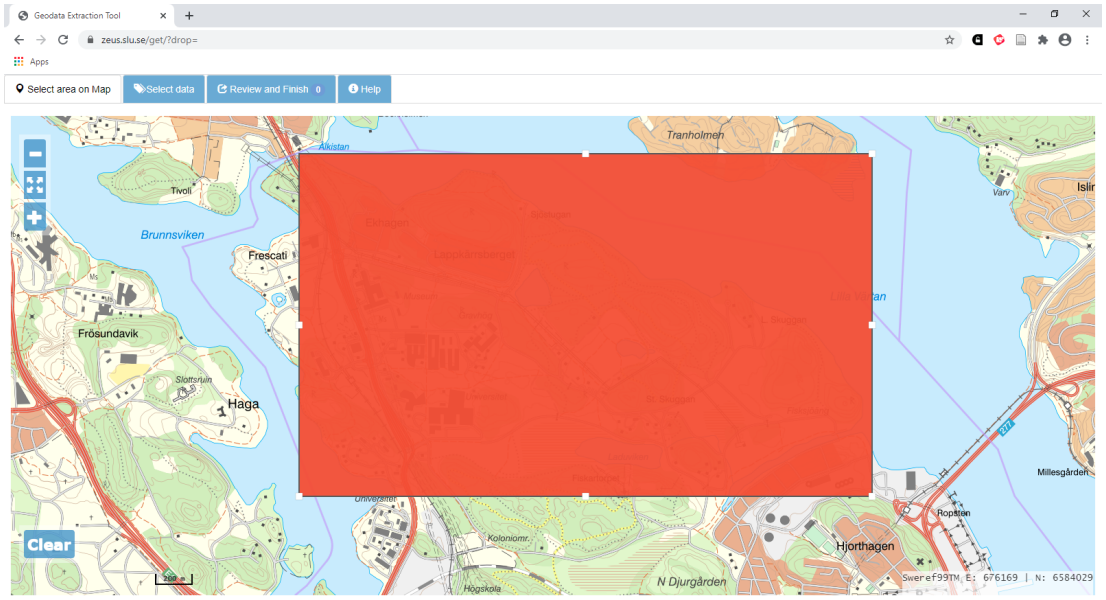
At the top of the screen you see four fields: 'Select area on map' (which is the current screen), 'Select data', 'Review and Finish' and 'Help'. The first three are the steps will will need to go through to extract our data. To the right you see three buttons with zooming (+, −) and panning tools. You can use these to move around and zoom in and out in the map. You can also 'grab' the map with the mouse pointer and move around and use the mouse wheel (or other zooming feature on your mouse or computer) to zoom. Finally there is a button called 'Draw'. When you click on this button you can use the mouse to draw a red rectangle on the map. This rectangle will be the area of data you will be able to select. Note that there is a limit to how much

data you can download so if you select too large an area, you will get a rectangle that is only partially red. You will then only receive the data covered by the red portion. The maximum area is still quite large so you will not likely run into this problem. If you need to cover a larger area you will simply need to do multiple downloads and move the red area so that you end up covering your desired area through multiple data requests.

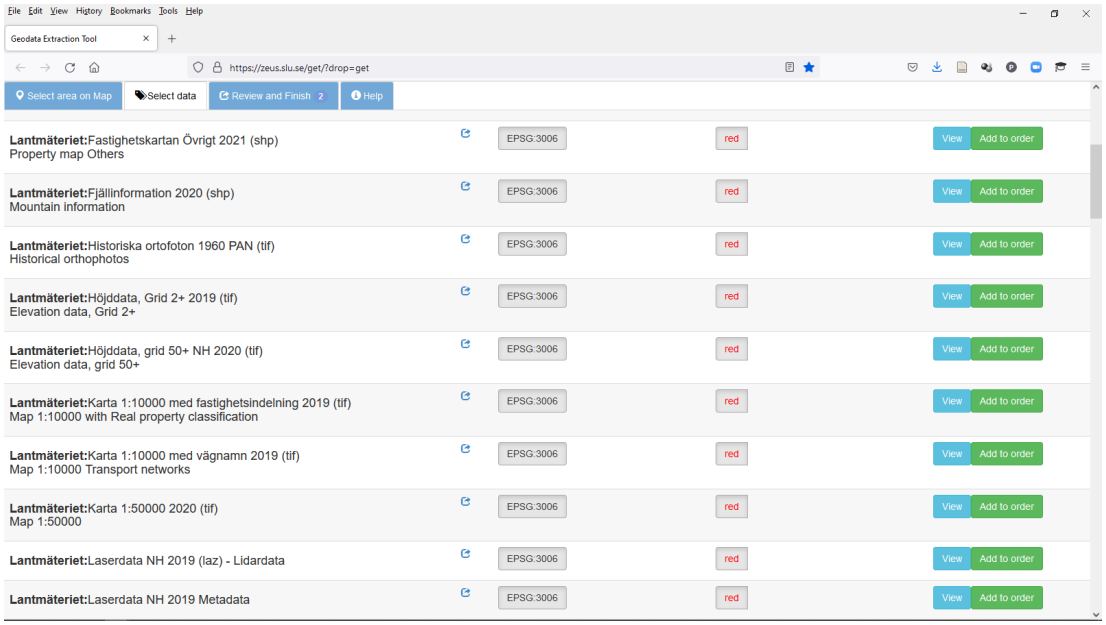
Let us now look at an example. I have decided to extract data over the Stockholm University campus and surrounding park lands. Therefore start by zooming in on the map until you obtain a view that covers the area of your interest, in this case the the area shown in the figure:



Once you have a map view that covers your area, we need to mark the area we are interested in. To select an area, you simply click on the button labelled 'Draw' and click and drag on the map until you get a rectangle that covers the area of interest. The result is a red rectangle showing the selection. Note that you can change the size of the rectangle by dragging the edges and you can also re-position the rectangle by clicking somewhere inside it and dragging it to the desired position.



Once we have selected an area, we need to select what data to download. We therefore press the 'Select Data' field at the top which changes the screen to the following:



What you see here is a long list of different data sets[3] open for download.

Data at the SLU site comes in two formats which are indicated by '(tif)' and '(shp)' in the name descriptions of each type of data. Data in 'tif' format is bitmap based and will be delivered in square pieces called 'tiles'. When you select an area, you will be sent the tiles that are required to cover your selected area. This means you will always receive more data than you have requested by the extent of your drawn rectangle. The

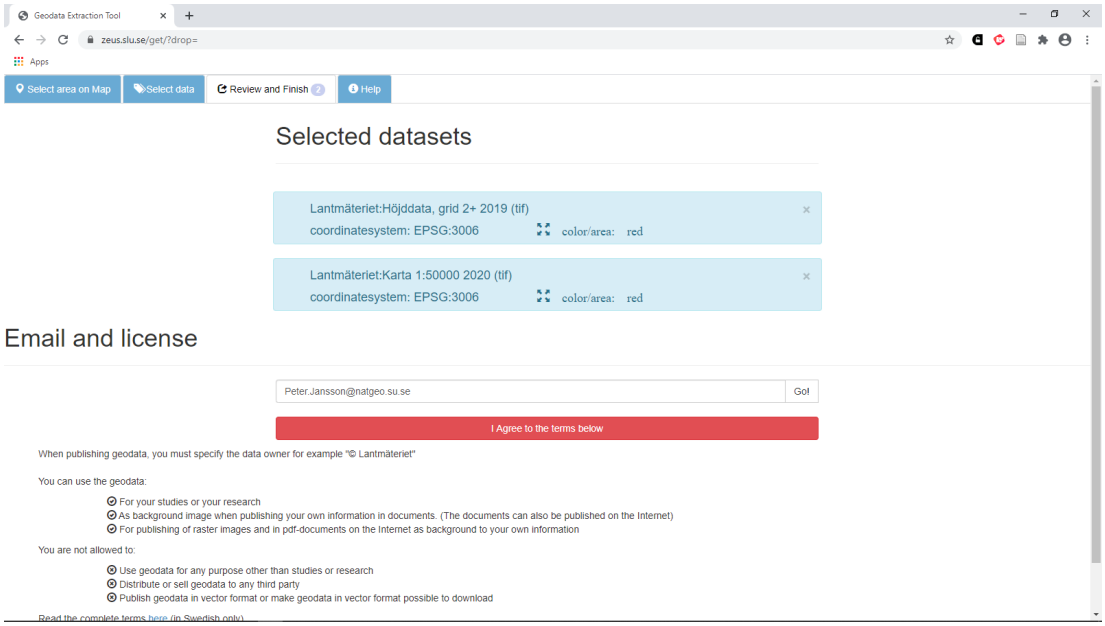
[3]Note that the SLU service may change the available data and the naming of the data sets without warning so if suddenly information provided here does not match what you see on the site, use your discretion to identify which data is useful to you. Also report sudden deviations so that this instruction can be updated.

'shp' format consist of vector based *shape files* where the data is represented by points, lines and polygons. This data requires deeper knowledge of GIS tools to work with and is not covered by this compendium. So if you want to explore additional data and you are not deeply familiar with GIS, look only at bitmap 'tif' data.

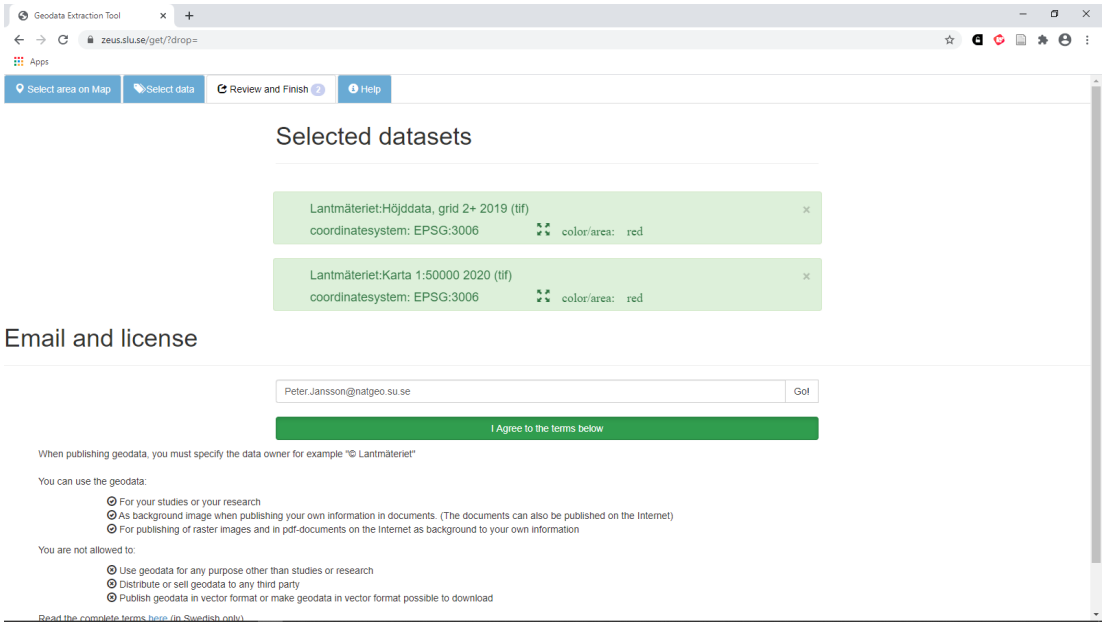
We will mainly focus on the '**Lantmäteriet:**Höjddata grid 2+ 2019 (tif)' but other useful data sets include the '**Lantmäteriet:**Karta 1:50000 2020 (tif)', which you may recognise as the normal topographic map, and perhaps '**Lantmäteriet:**Ortofoto RGB 0.5 m latest (tif)' which is a photographic map showing the ground. There is also a infrared ortophoto data that can be useful if you know how to interpret such false colour images. These can be useful when interpreting the terrain data.

Downloading the 'Karta 1:50000' data can prove to be useful since it will provide you with a readable map showing you what it is you see in the terrain data. So I strongly suggest you download also this data routinely.

You can select from the list by pressing the green 'Add to order' button. Once you press it it will turn white. If you want to select several different data sets for the same area you simply continue adding data sets to 'order'. When the data set has been selected press the 'Review and Finish' field. Note that the field now shows a number indicating indicating how many data sets have been selected. A new screen will open showing the selected data sets:



This screen shows the selected data set(s) as blue fields. In order to download data you now have to accept the license agreement (please read and understand the terms!) by pressing the red bar with the text 'I Agree to the terms below'. The red bar turns green indicating you can proceed to download data. You then press the 'Go!' field to the right of your Stockholm University mail address (which should be shown). The processing is then started and the blue data field turns green:



Which indicates that your order has been processed.

The data we have selected will now be provided as a zip file which can be downloaded through a link in an e-mail you will receive. The e-mail subject message will read, for example, *Here is your Höjddata, grid 2+ 2019 (tif) order […]* in the case of 2 m elevation data. Simply click on the link in the e-mail and save the zip-file on your computer. The file (exemplified by elevation data) will have a long name similar to `H_jddata_grid_2_2019_tif__a97c29fa-6cf4-4259-a327-2f4bbe4e7ec8_.zip`.

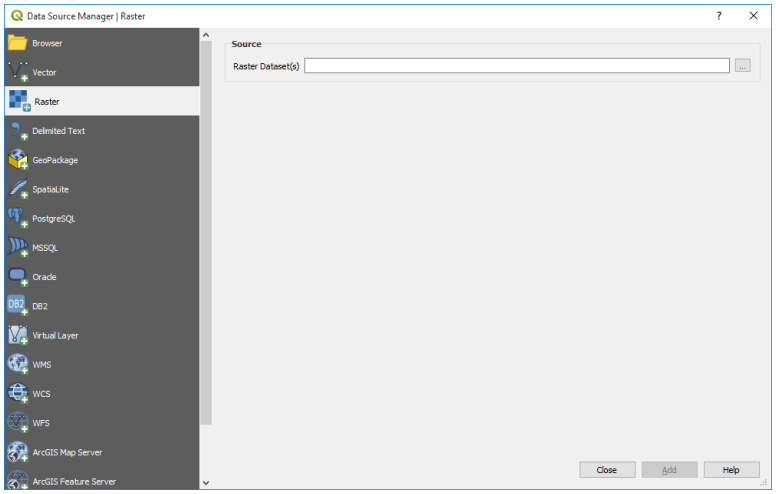
The zip file contains the data and a couple of folders. The folders are called 'Documentation' and 'metadata' and contain information about the data you have downloaded. The data comes as a number of `.tif` files. These are GeoTIFF files, which means they contain the elevation data as a raster but also that the raster is georeferenced so that the true coordinates for the data is included. It is possible to view the files in any image viewer and what you will see is a grey scale image where white is high elevation and black is low. The files will jointly cover your selected area.

Once you have your zip-file downloaded I recommend that you create an empty folder and name it with a name that indicates the area the data covers. In my case I call the folder 'Frescati' since it covers the Frescati area of the university campus. Next unzip the content of the zip file into your empty folder. I strongly recommend you to avoid accented letters such as å, ä and ö in your file and folder names. Also, you may consider creating a new folder inside your project folder called DEM or something similar and move the elevation data into this folder to separate the files from other data.

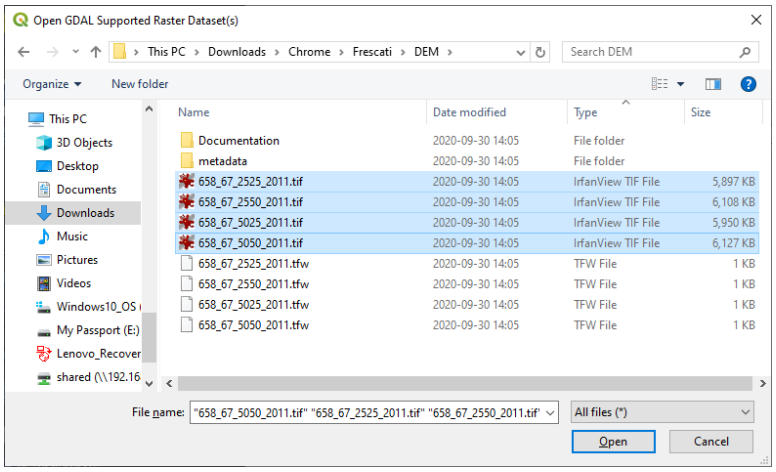
6.2 Opening and merging data tiles

In this section we will look at how to get the elevation data into QGIS and to create a shaded relief from the elevation data.

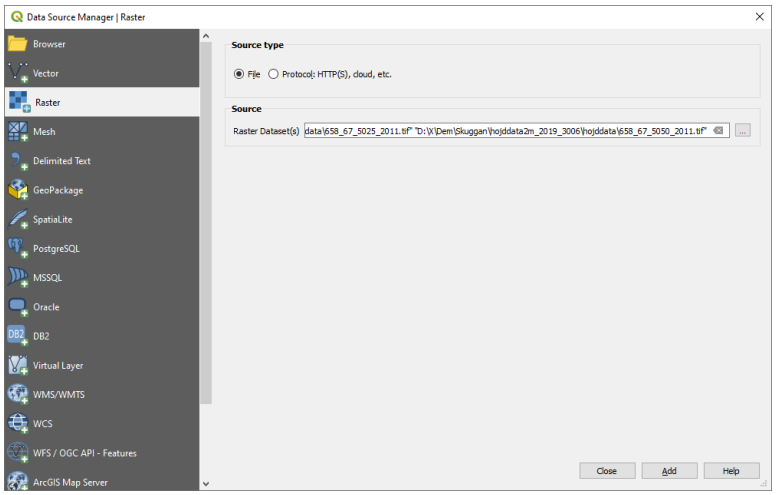
We start by opening QGIS and make sure we have a new project open (menu: Project/New). To add the elevation data we need to select Layer/Add Layer/Add Raster layer…. This will open a dialog called 'Data Source Manager|Raster':



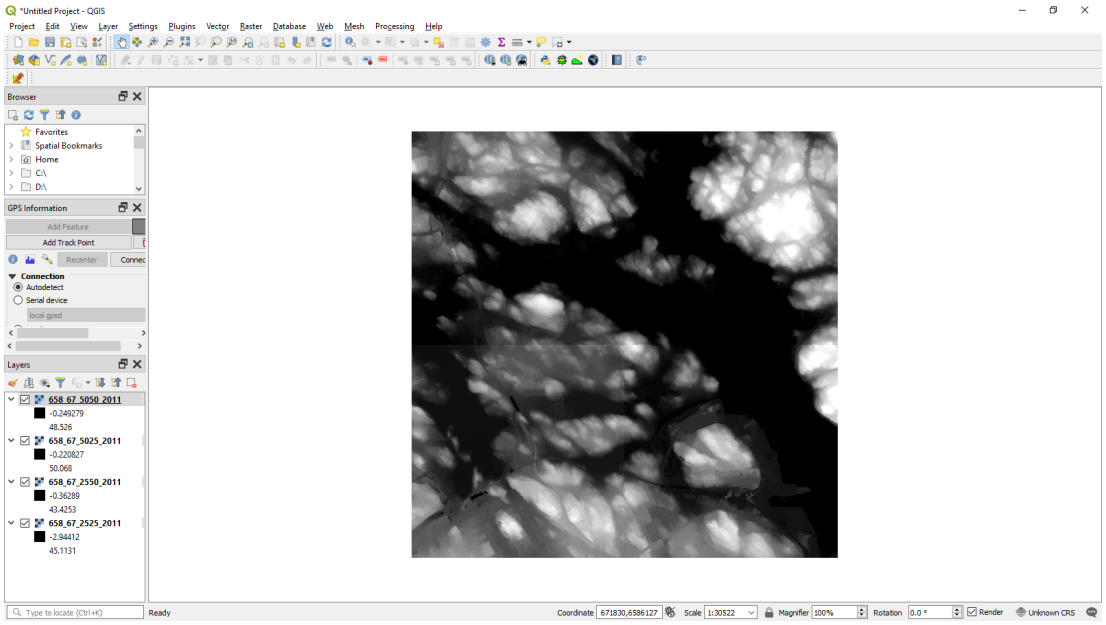
The 'Raster' entry will be marked and you can now select a source file by pressing the ... button to the right and locate the data you downloaded.



The files you should upload will be the `.tif` files in the folder 'DEM' so you need to mark all such files



The Data Source Manager dialog will now show the file names. You then press Add and Close at the bottom of the dialog. Your QGIS window should now show the digital elevation model (DEM) based on the data as a black and white picture where black is low elevation and white is high.

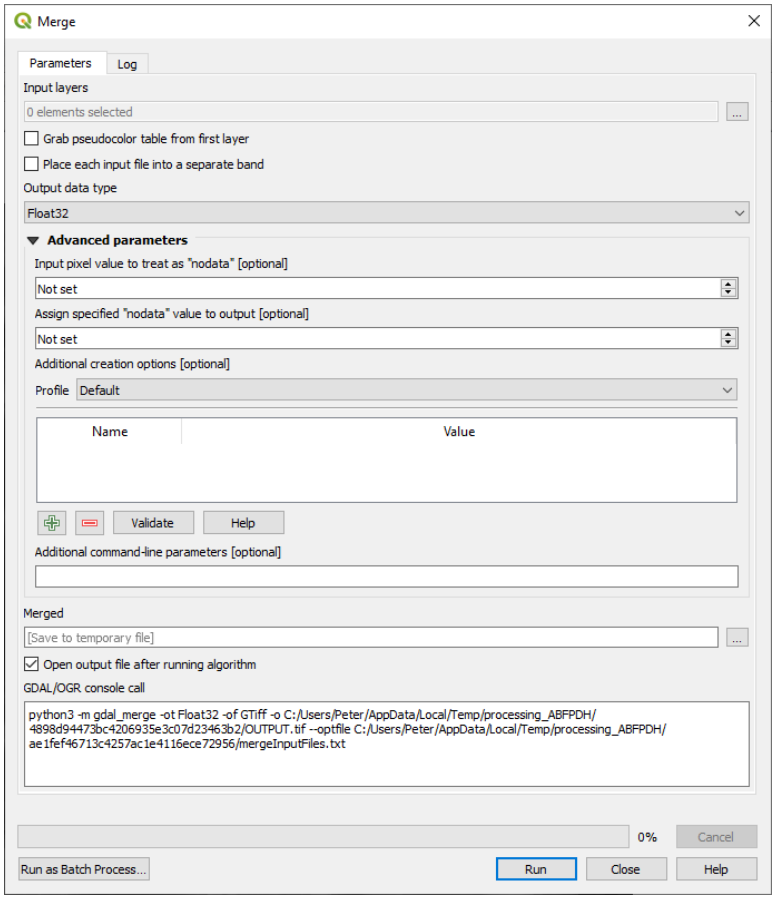


In the pane on the lower left you can see that we have added four tiles that make up the data for the area we selected earlier. But, we can also see that the data covers a much larger area than what we originally ordered when we drew the red rectangle on the SLU web page. Rather than extracting the data covered by our order rectangle data is provided in a set of square tiles that jointly provide the coverage we want, and more.

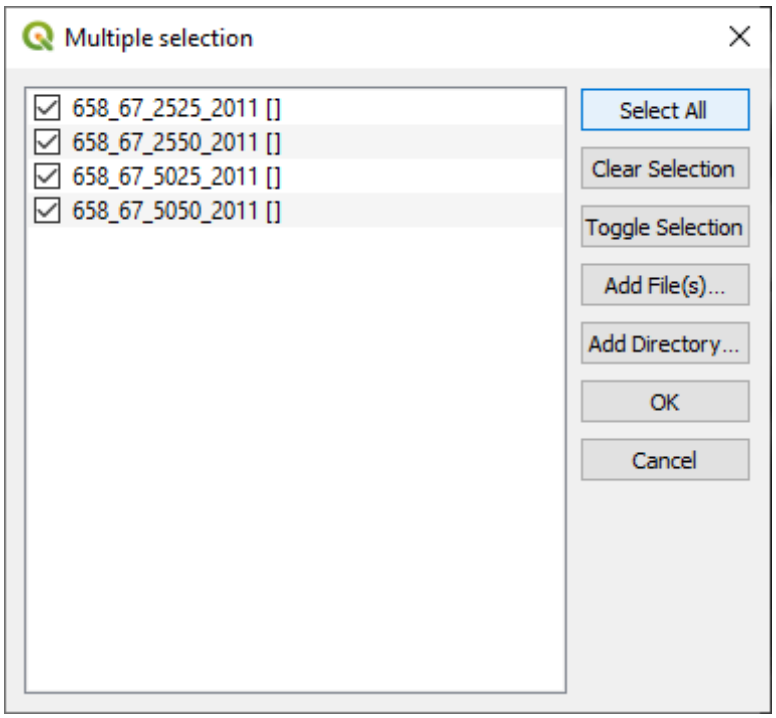
Before we continue, this would be a good point to save our project so that we can continue saving our progress as we go along. Simply select File/Save as and save the project file. I suggest you name the project file with the same name as you named your project folder and also save the file into the same folder.

The fact that we now have several tiles means we need to merge these together to form one continuous data set. If you look carefully in the image above you can see faint joints where the tiles meet each other indicating that the elevation scale of each tile is set separately in each tile and will not allow us to work with the entire area to yield satisfying results.

To merge the tiles involves using a merge tool which is found in the menu Raster-/Miscellaneous/Merge. This opens a dialog that allows us to add the tiles we want to include in the merge (usually all tiles we have downloaded) and to provide a name for the merged data set and also where we want the data set to reside. Click on the ... to the right of the Input layers field

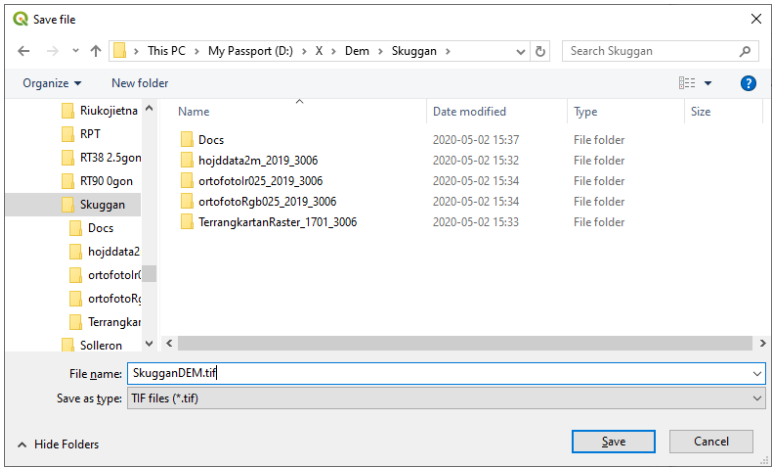


and select all tile files you want to include in the new Multiple selection window that opens and click OK to add the tiles.

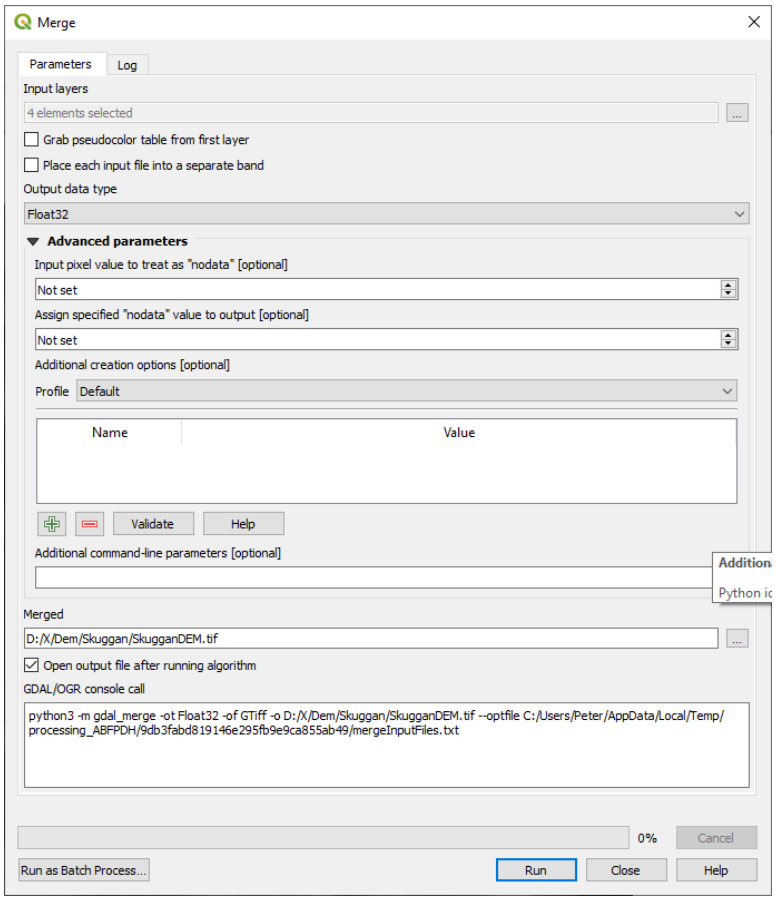


Then you need to tell QGIS where to store the merged grid. Click on the ... to

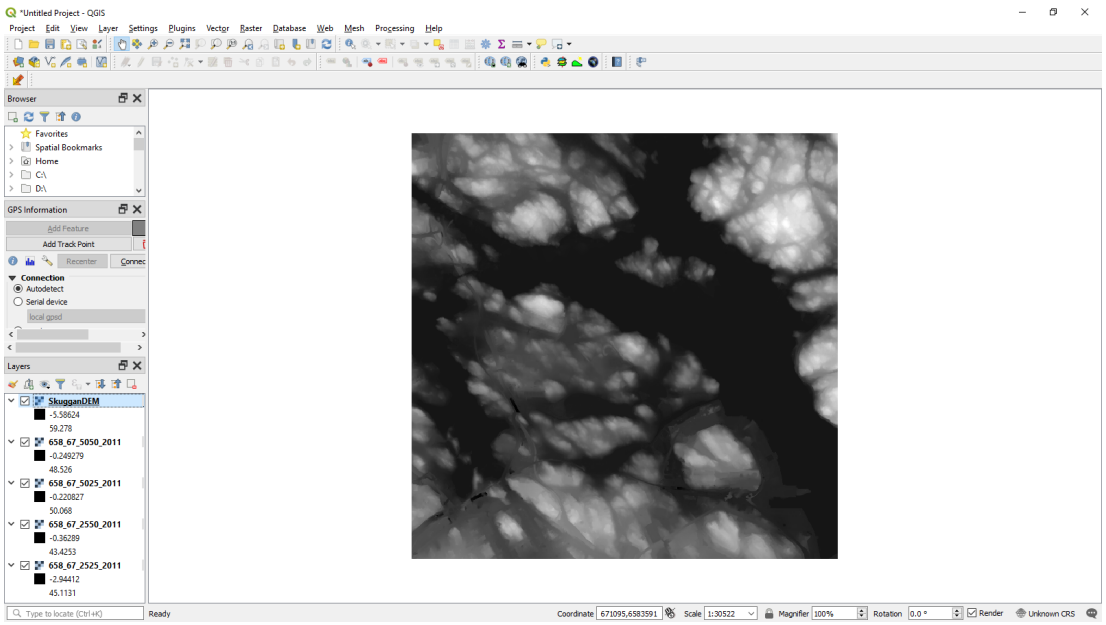
the right of the Merged field lower down on the Merge dialog. You will then see three options, one of which is Save to file. Selecting this opens a dialog that allows you to name your merged DEM and also where to place it. It is useful to name the output file in a way so that you know which project it belongs to and what it is. So in my case I have chosen to call in 'SkugganDEM.tif'. I strongly recommend saving it in your project folder.



Once you have filled in these fields you can press the buttons Run followed by Close and QGIS will merge the tiles.



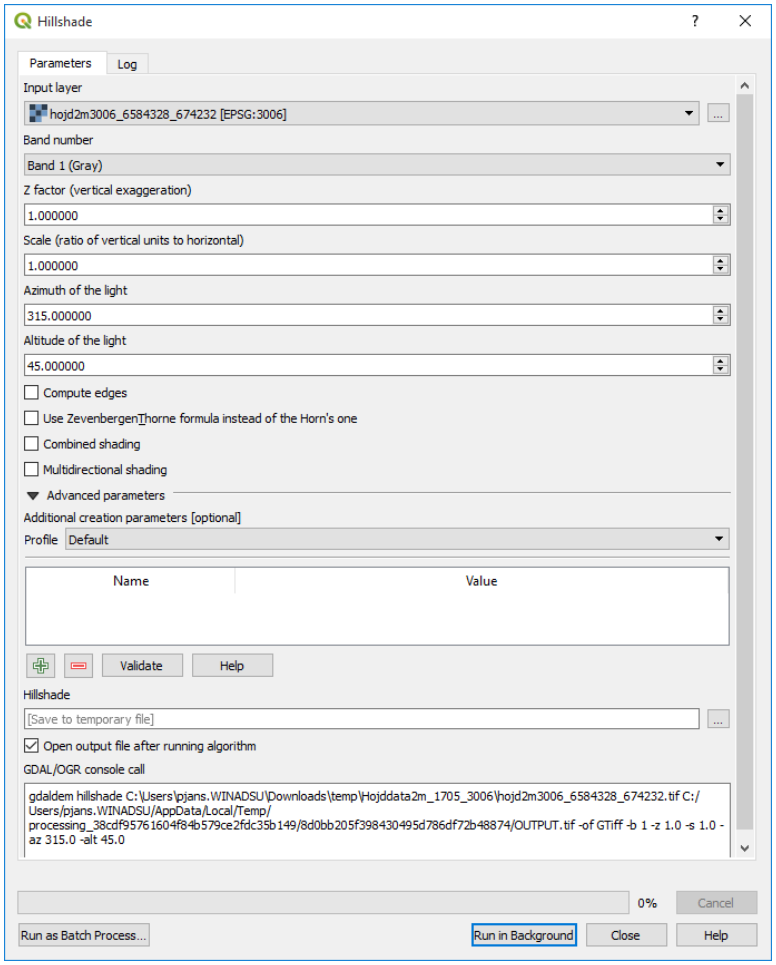
When the merger is complete, you will see that a new layer has been completed and added to your GIS. The name of the layer is the name you provided above.



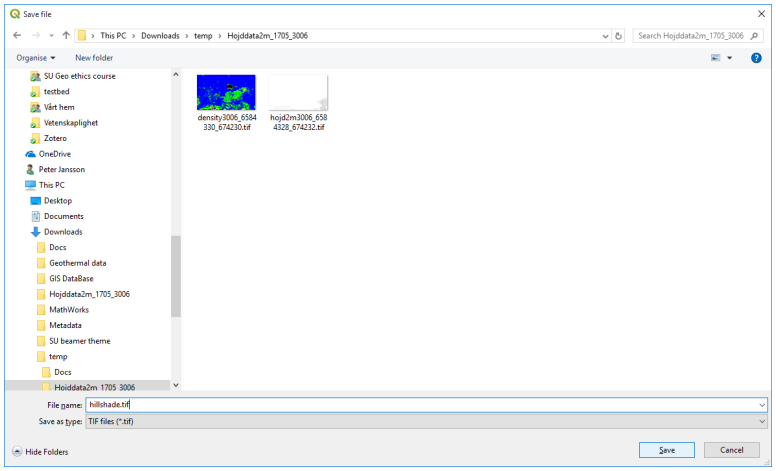
If you want to you can now remove the tiles that you first added to the project before merging them. This is not necessary but you will not need the tiles in the future. To remove the tiles (or any layer) simply click on it in the layers pane to mark it and press the square with a red minus sign at the top right of the pane that lists the layers.

6.3 Making a hill shade model

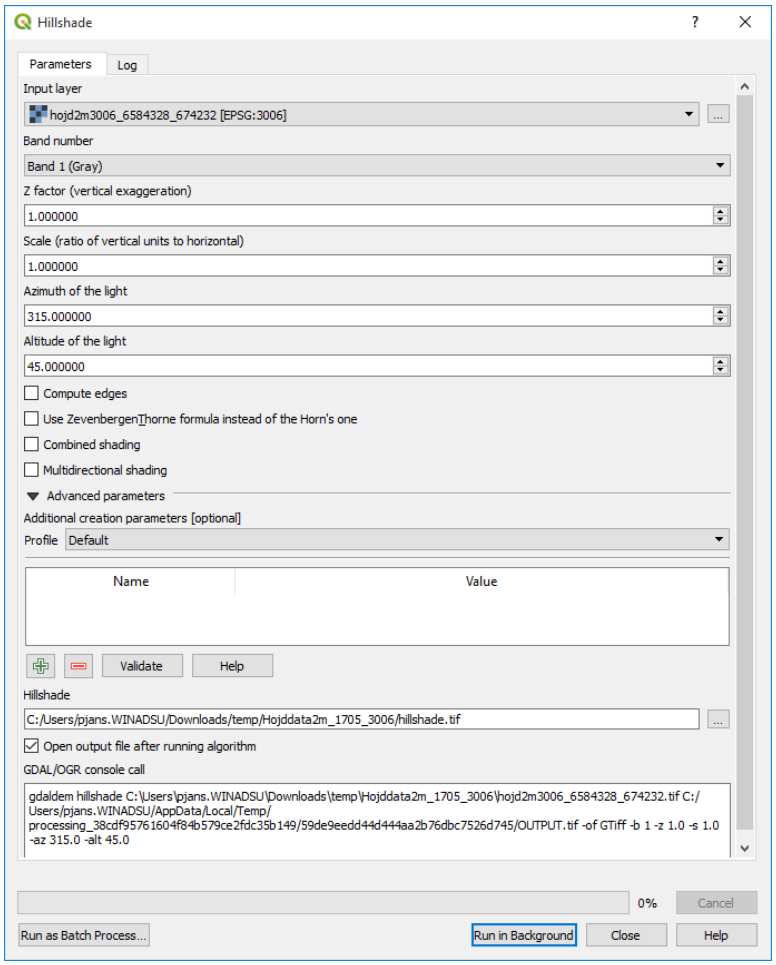
We will now analyse the DEM to produce a so-called hillshade layer. A hillshade is a technique that simulates the highlights and shades of a surface when lit from a specific location. As humans we have the ability to use such shading to experience the three-dimensionality of an object, or in this case our terrain. To start the processing we need to select Raster, Analysis and Hillshade in the menu. This opens the Hillshade dialog:



There are many options in this dialog but we will just use the default values which usually work very well. We first need to make sure that the 'Input layer' shows the name of the elevation data. If the elevation data is the only layer you have in your project then this will be chosen automatically. The only thing we need to enter is the name and location of the resulting hillshade file. In the lower half of the dialog you find a field called 'Hillshade' where you can add a file name. Click on the ... button and select 'Save to File...' option that appears in a small temporary dialog. You should then locate the folder where your original elevation data was located and type in a name for your hillshade file in the 'File name' pane. I have chosen to just call it `Hillshade.tif` in this example.

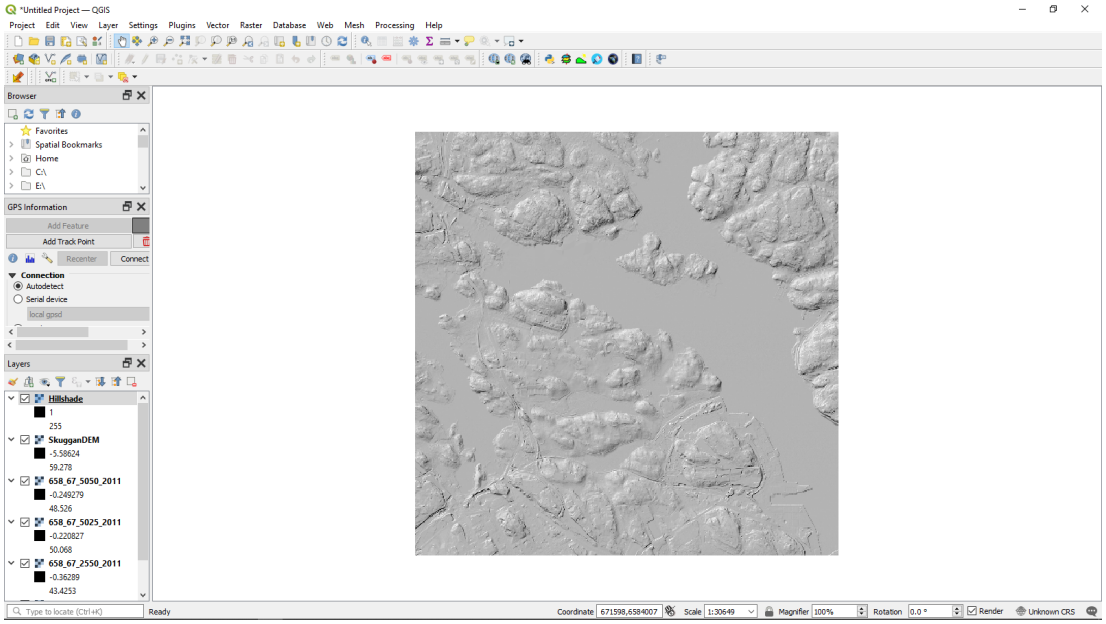


The reason for saving the hillshade file in the same place as the original elevation data is to keep all your files together. Once you have typed in your file name, press Save. The file name shows in the Hillshade dialog.



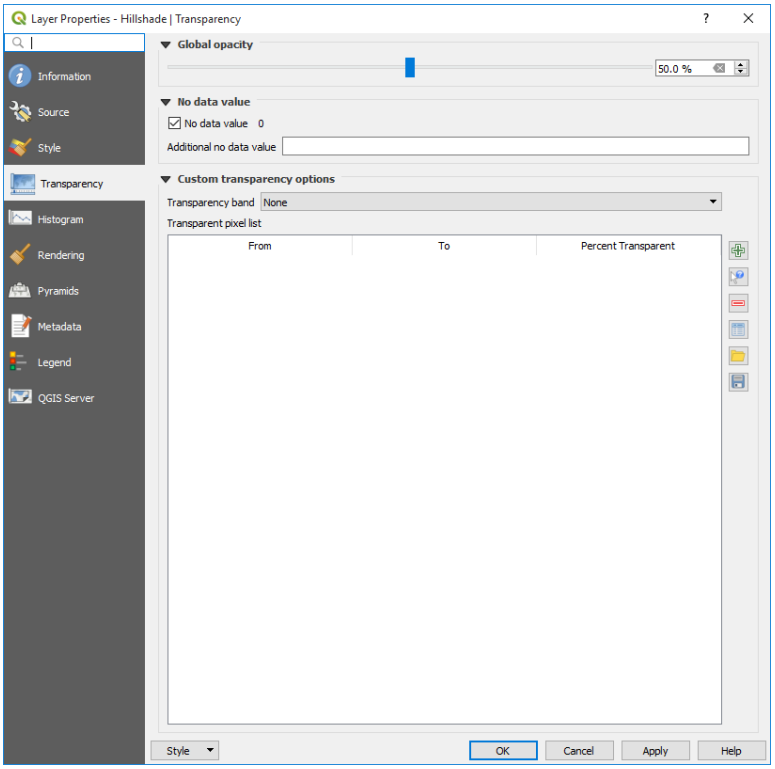
To process the Hillshade press the Run in Background button followed by the Close button at the bottom of the dialog.

The QGIS window should now show the shaded relief instead of the black-and-white DEM.

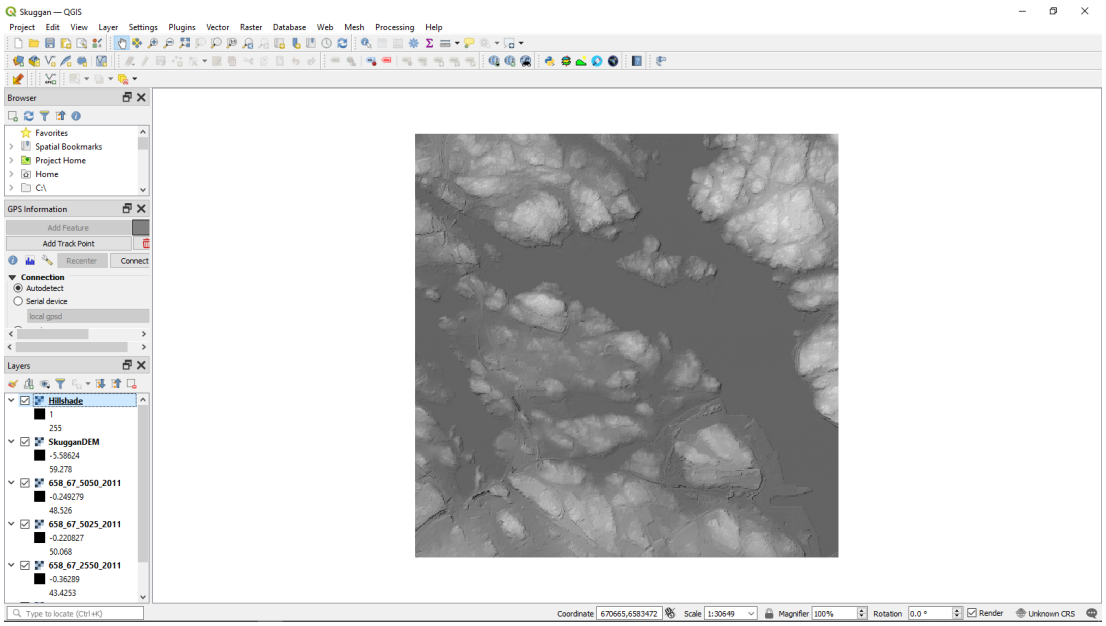


At this point it is worth noting that in the lower left of the QGIS window you see two entries, the elevation data file 'SkugganDEM' and the 'Hillshade'. These are layers. The reason the Hillshade is shown is because this layer is on top of the DEM. You can turn the Hillshade on and off by checking and unchecking the Hillshade layer. You can also reorder the layers by dragging and dropping the layers in the order you want them. For now the original order makes most sense.

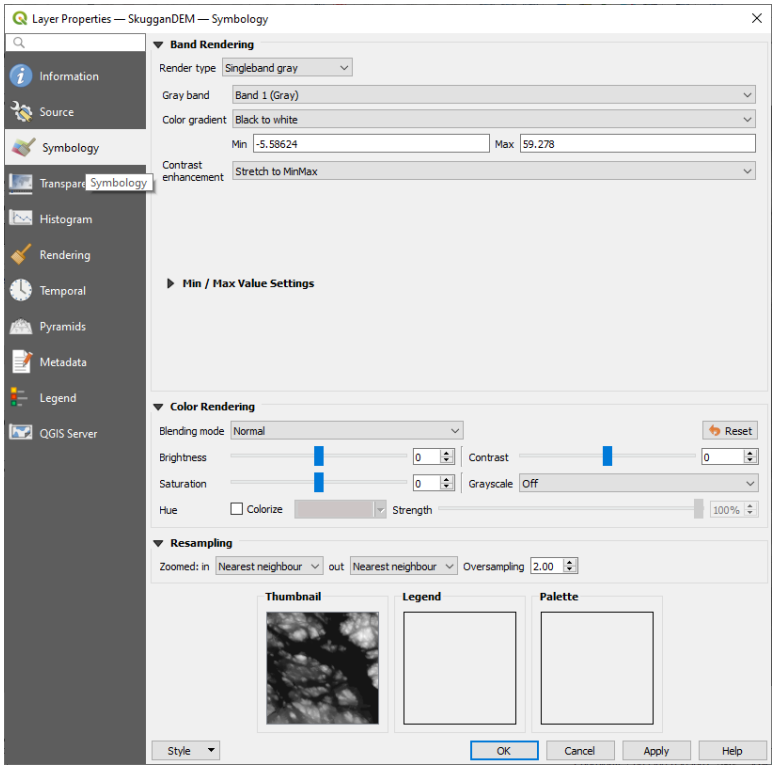
Once we have established the DEM and hillshade layers we can start modifying them a little. We will begin by looking at 'Transparency'. If you 'right-click' on the Hillshade layer in the layers pane, you will get a dialog with several options. Select the 'Transparency' option by clicking on it.



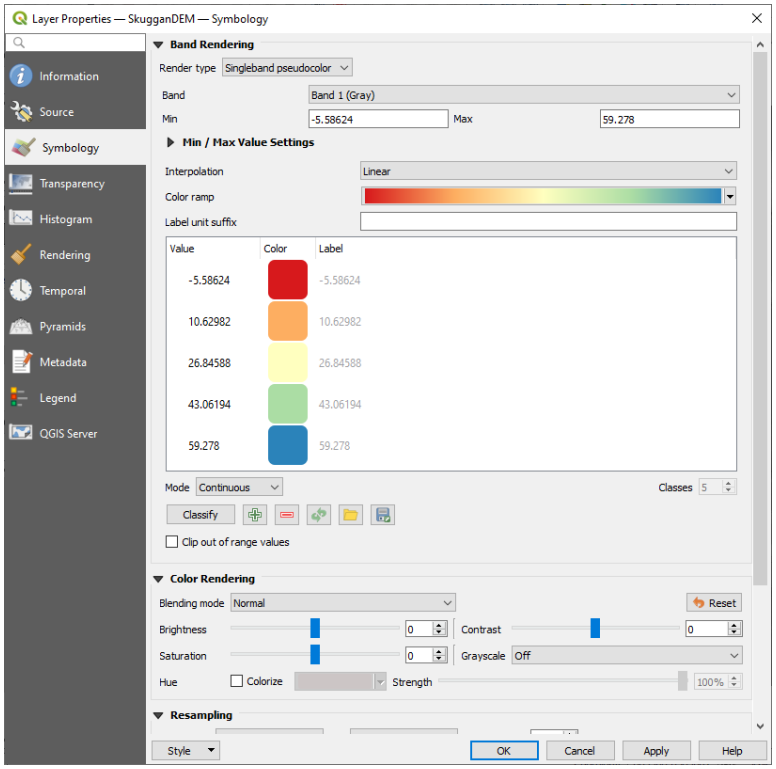
This allows you to change the transparency of the hillshade layer. The default is 100% 'Global opacity' which means the layer is totally opaque or has no transparency. Change the value in the box at the top right corner from 100% to 50% and press Apply and Close at the bottom of the dialog to see the result:



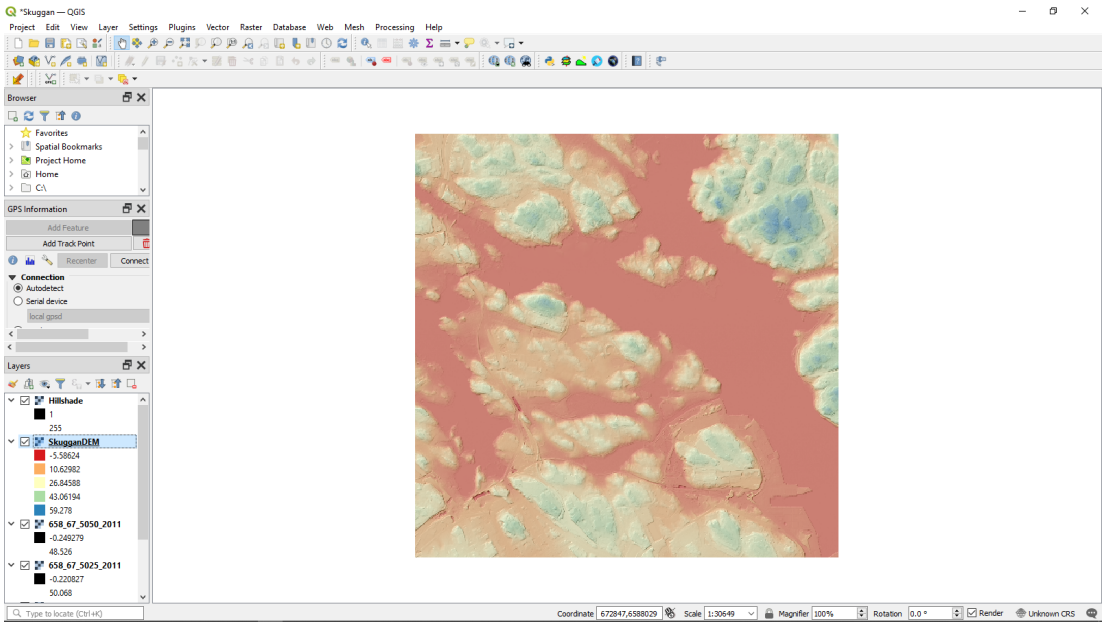
We can also modify the DEM layer. Let us add some colour to it by 'right-clicking' on the elevation layer. This opens the Layer properties dialog for the layer. Select the 'Style' option by clicking on it.



As you can see there are several things we can change. We will start by clicking on the 'Render type' selector and chose 'Singleband pseudocolor' from the options. Then we will click on the 'Color ramp' and select the 'Spectral' option. The dialog will then look like this:

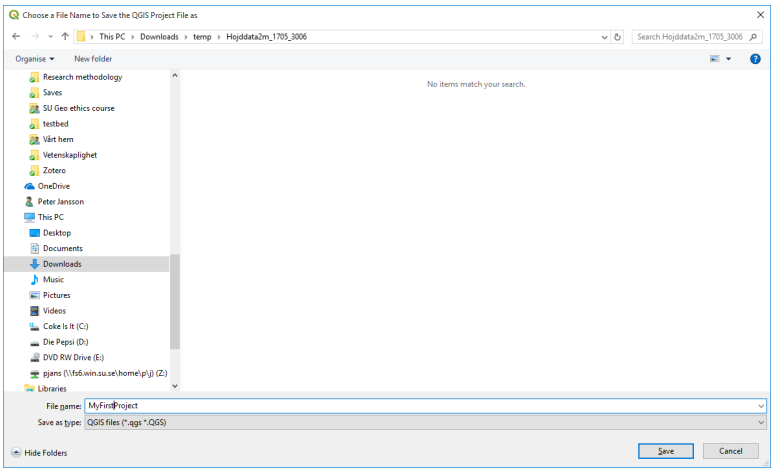


Now click on Apply and Close and the GIS project will look like this:



What you see now is that the elevation data goes from red at low elevations to blue at high elevations and that the shaded relief effect is still there but 50% translucent to show the coloured DEM. This indicates how you can work with the layers to create a good end product that gives the viewer information on elevation and relief.

A final point before ending our session is of course to save the work we have done in a QGIS project file. Click on Project, Save As... and locate the folder where your data is located. Add a name for your project file in the 'File name' field. QGIS adds the extension `.qgz` automatically



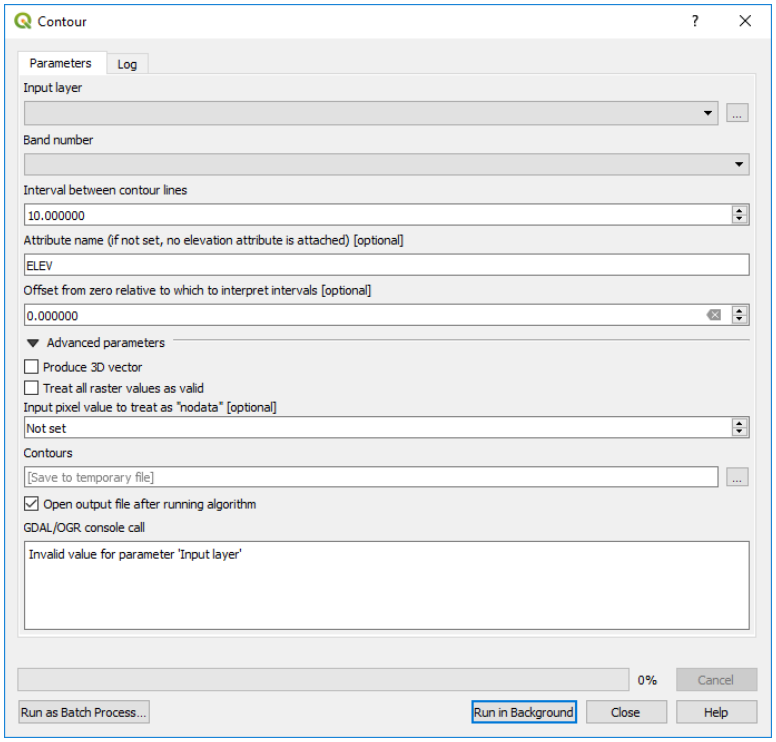
click Save and you now have the project saved. I have given the project the name 'Skuggan' since it covers the area Stora Skuggan in Frescati. All you need to do later to open the project is to open this QGIS project file (`Skuggan.qgz`).

One word of warning is due here. QGIS has problems with accented letters such as å, ä, ö, é, etc. in names so please use only non-accented names. If you, for example, have a map over Åmål you may need to name the project file `Amal.qgz` or `Aamaal.qgz`. The same applies to the folder name on your computer if they are involved in the project.

7 Creating contours

When you have an elevation model, it is useful to add contour lines to visualise the topography. This is easy in QGIS. Let us add contours to our project 'Skuggan'. To be able to see details better, I will show results in a zoomed in view covering the Stora Skuggan area.

Click on Raster menu item and select Extraction/Contour. This opens a window with settings for the contouring as follows



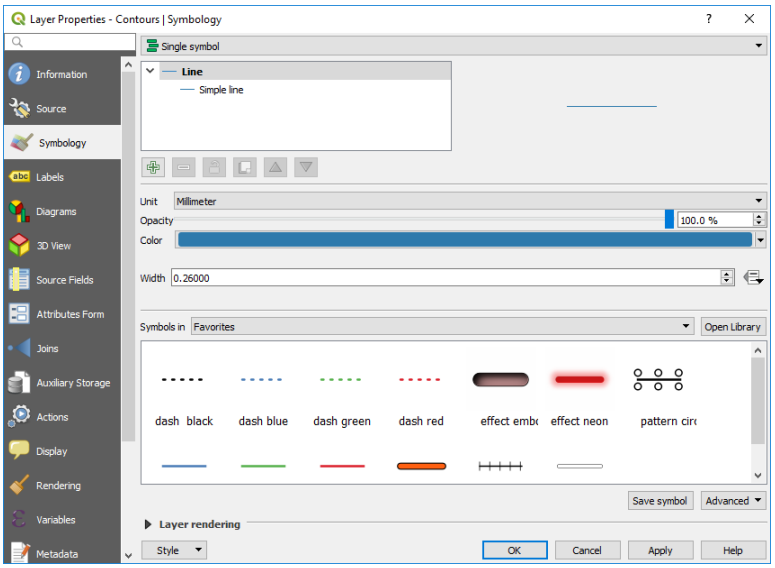
Here you need to, check, change and add a few items. First you need to select the input layer in the first field of the window. Make sure you select the elevation data as input. Second, you need to decide what elevation contour interval you want. This is done in the field conveniently labelled 'Interval between contour lines'. The default is 10 m. The third item is the field labelled 'Contours'. This is where you can add the file name of a file that will contain your contour information. If you do not enter a name so that QGIS saves the contour information, it will be stored in a temporary file that will be lost once you close the project.

Once you have completed the fields you can press the Run in Background button followed by the Close button. QGIS will now calculate and add a layer with contours. For a large map and large number of contours, this may take a while. This layer will appear above the elevation data layer so if you have a hillshade layer this may obscure the contour layer. You can simply grab the contour layer in the Layers pane and move it to be overlaying the hillshade if that is what you want.

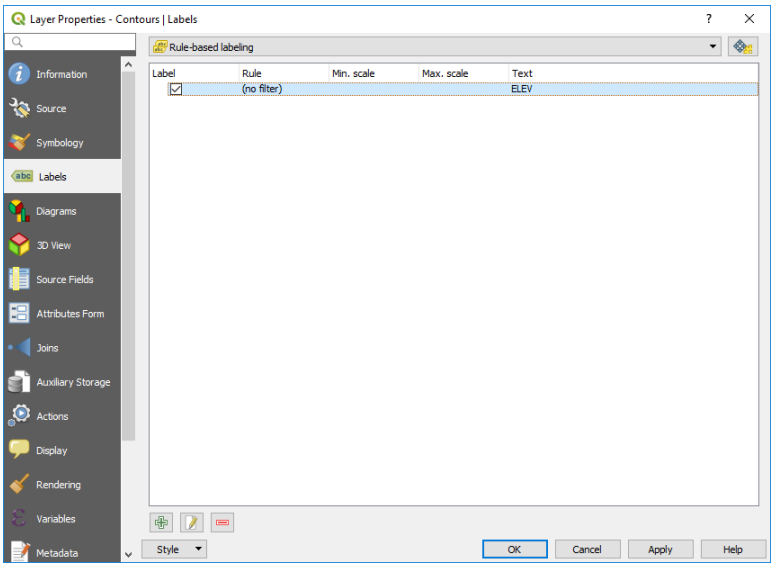
We can now make changes to the the look of the contours layer. The contours will be given a colour by default which sometimes is not useful, it may, for example, be to light and not contrast the background. To make any changes, right-click the Contour layer in the Layers pane. This opens the 'Layer Properties' window.

To change the colour of the contours click on 'Symbology' in the list of different properties to the left in the window. Here you can change the colour and width of the

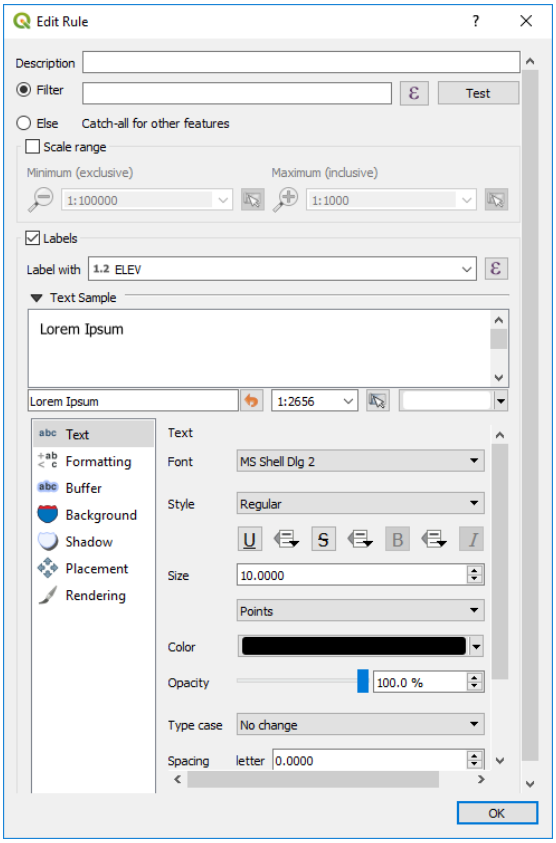
contour lines as well as other aspects of the lines.



Select the colour you want by clicking om the 'Color' selector and make any other changes you may want. You can always go back and change these settings later. Finish the changes you have made by pressing the Apply and OK buttons.

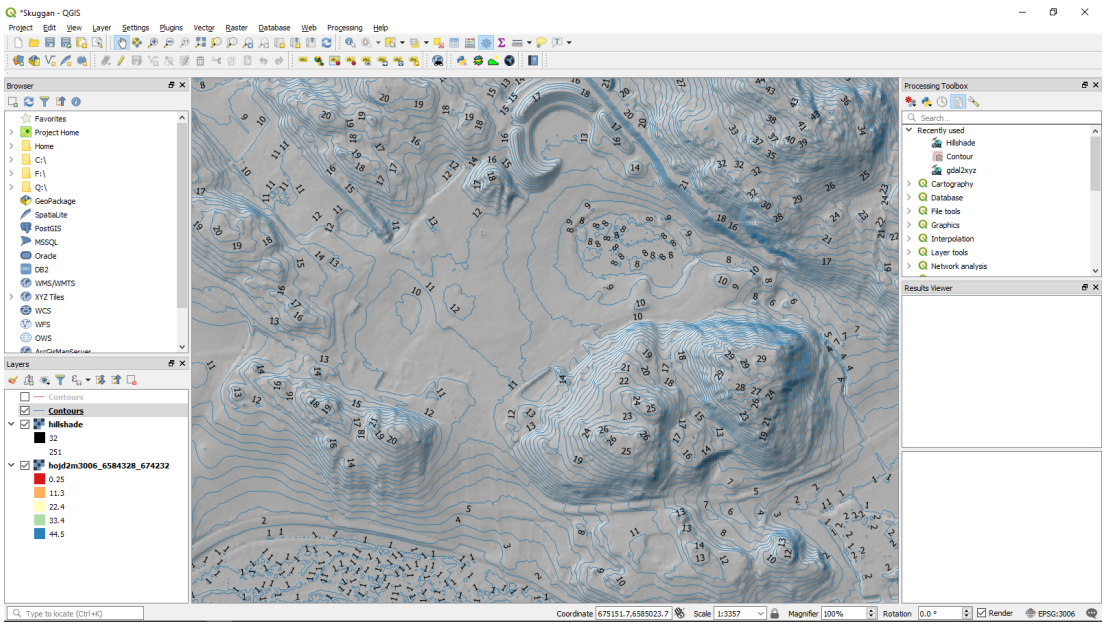


Once we have changes the colour of our lines we might consider adding contour labels. This can be done in the 'Labels' section of the properties. Here you will start by adding a label through pressing the + button at the bottom of the window. This opens a new window where you can add the details of what you want to display.



Here you can name the labels so that you know what they are in the 'Description' field. More important is to chose the correct field to use to display values. In our case we accepted the default attribute name of `ELEV` when we started the contouring (see above). We thus select `ELEV` as the data to create labels. You can then play around with all the other settings for how the labels should be type set. In this case I have simply accepted the defaults. Finish by clicking the OK button.

The resulting map shows contours and labels on the contours.



It is evident that the labelling is not optimal. By default each individual loop of a contour is labelled which, for example, yields a large number of 1-m labels in the irregular micro-topography in the lower left corner of the map. For the purpose of what we want to achieve, to investigate topography, we can live with this. With time during your education you will learn how to make maps that are nicely formatted so this is just a start.

8 Postscript

When you run through this introduction, you can easily expand your knowledge by trying out different settings to see what effect these may have. You should also search the internet for hints on how to accomplish specific results in your analysis.

Version description

Ver.	Date	Description
3	18 Nov., 2021	Minor adjustements to the text including the latest changes on the SLU site.
2	5 Oct., 2020	Made changes to accommodate changes on the SLU site and also in the format data is supplied. A tiled data format was introduced without notice in Jan. 2020 on the SLU site. Minor typos have also been corrected.
1	3 Nov., 2018	First version.