Tutorial: Basics of Land Surveying

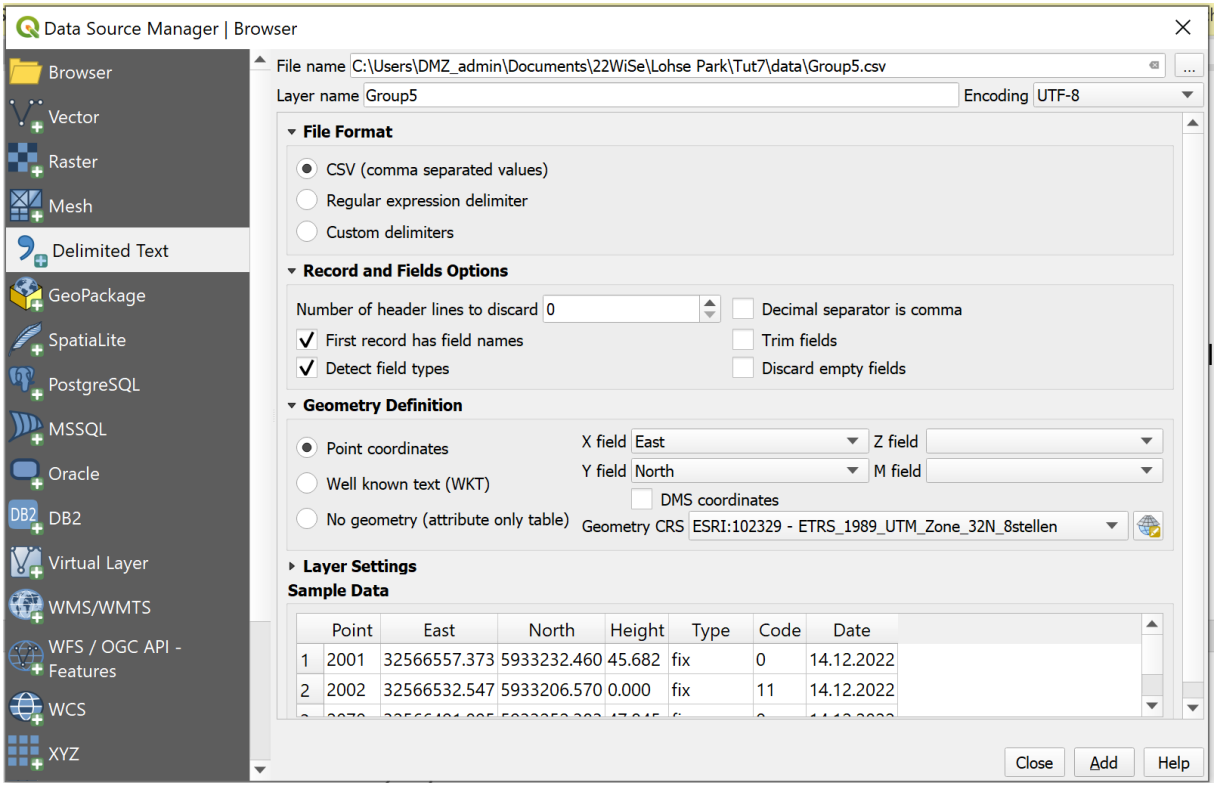
Part 7: Evaluation of the topographic survey

Create a new folder in your personal folder. Download the provided geodata from HCU moodle and save them in your folder.

First of all, have a look at the data. Open your group file in a texteditor (e.g. Notepad++) and validate whether your measurements produced geodata with point IDs, coordinates, heights and code. If you have something to correct from your fieldbook, do it now. Delete erroneous measurements!

Then let´s go on working with QGIS:

1. Start QGIS and open an empty new project. Save it and give it an appropriate name.
2. **Import geodata** in QGIS:
   The coordinates of the measured points are saved in an Excel table (csv-file). They can be imported into QGIS as a Delimited Text Layer.
   Menu: Layer → Add Layer → Add Delimited Text Layer
   Choose the particular Excel File, make sure to set the correct Geometry Definition (X field, Y field, Geometry CRS)



   Click “Add” and “Close” and your data will be displayed in your window as coloured points.

3. Next we add some **auxiliary background data**:
   Add OpenStreetMap from the Browser Tap → XYZ Tiles to your project by Drag&Drop in your map window.
   If OSM is not yet connected in your Browser Tap:
   XYZ Tiles > right click > new connection and enter a name and paste the following corresponding link: https://tile.openstreetmap.org/{z}/{x}/{y}.png

Now you are able to check, whether your data points coincide with the background data from OpenStreetMap.

Next we want to separate the different **object categories** which has been measured:

4. The information and attributes are visible in the **Attribute Table** of the geodata. The table can be displayed by making a right click on the corresponding layer in the layer window (Open Attribute Table).
5. The points in the table belong to different objects categories (wayside, trees, etc.). In order to create an adaptive map, the individual objects shall be presented in different layers.
   To ease the layer handling and point editing, the points associated with the individual categories are exported to separate files. The proprietary file format is ESRI shapefile (*.shp).

   In the table below the different object categories which have been used in the field are listed:

Table 1: Object category codes

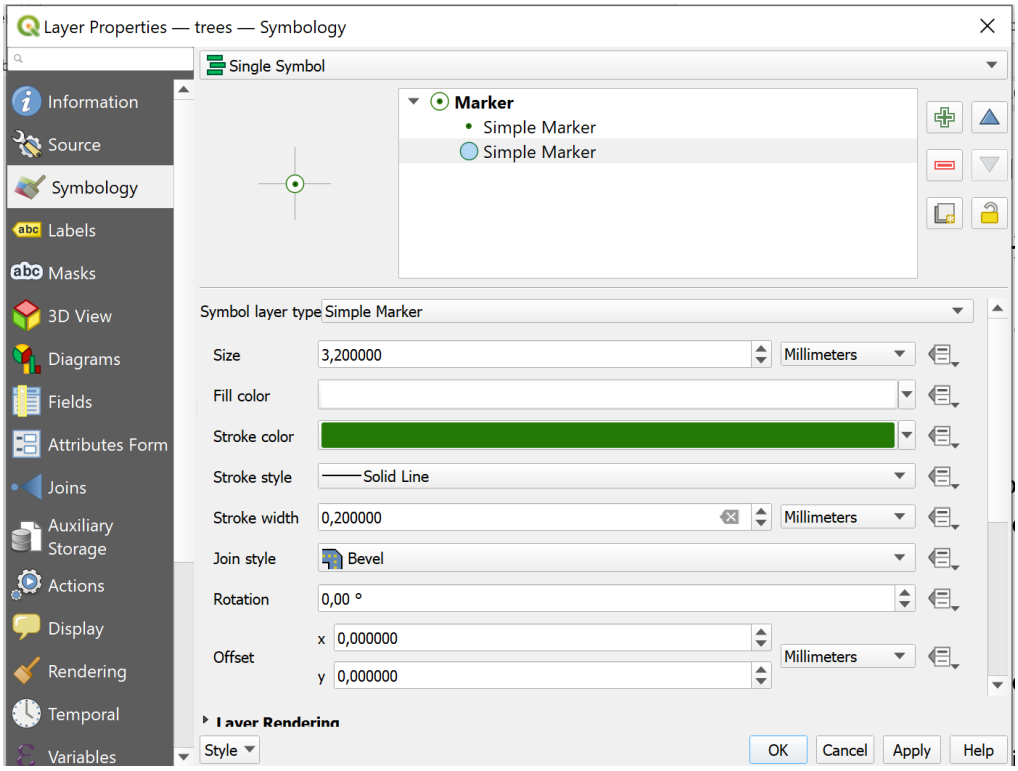
Code	Object category
1	Building
2	Fountain
3	Bench
4	Sandbox
5	Playground equipment
6	Sports field
7	Flower-bed
11	Wayside
12	Wall
13	Fence
14	Stairs
101	Tree
102	Bush
103	(Street) lamp
104	Gully
106	Rubish bin
107	Traffic sign
110	Pole
111	Other point
112	Topographic point

Mark all objects of the same object category (e. g. wayside PA =11) in the Attribute Table, the marked points are also highlighted in the map as yellow.
In order to export them into a new shapefile, make a right click on the layer → Export → Save Selected Features As…
Choose a distinct file name and set correct format and CRS → OK

Clear the selection and repeat this export procedure until there is a shapefile for each used object category.

6. The **spatial extension** of the individual object category can be distinguished into point-shaped, linear and laminar objects. According to their spatial extension the representation of the individual object category in the map has to be specified.

Point-shaped objects
Point-shaped objects can be represented by adequate symbols (e. g. lamps, trees, etc.).
Double click on the particular layer → Symbology
By selecting Single Symbol you get many options to create different marker. E.g.:



When choosing “Symbol layer type” as “SVG Marker” a wide variety in SVG symbols are offered.
→ Choose an adequate symbol in the overview and adapt it (color, size, …) → OK

Linear objects
The created shapefile can only contain one type of spatial extension ➔ Points. In order to create a (poly)line, a new empty shapefile has to be created. New shapefiles can be created by Layer > Create Layer > New Shapefile Layer: 

Choose a distinct name and select the geometry type as “Line”. Select the correct CRS → OK

In order to create a linear object, it is meaningful to fade out other object categories: Remove the checkmarks of all other objects/layers. Only the empty shapefile and the corresponding layer including the nodes shall be activated.

To create lines the *Digitizing Toolbar* and the *QGIS Plugin QAD* are used. Install the QAD Plugin in the Plugin Manager (Plugins > Manage and Install Plugins… > search for QAD > Install). Now a bunch of new tools appear in the upper panel.

Linear objects are created in the editing mode with editing tools. For that purpose:
Right click on the empty shape file → Toggle Editing (a yellow pen appears on the layer).

Use the line tools of *QAD* to create your polylines: 
In order to digitize a linear object, click on a node which is suitable as a starting point of the object. Click on the neighbouring point until the linear object is completed. Finish the individual object by clicking Enter. Several linear objects can be created in one shapefile.

Tip: Enable Snapping under Project > Snapping Options to be able to snap to the measured points when drawing new lines.

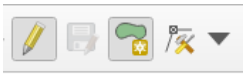
Save the digitized objects time by time: Right click on the layer → Save Layer Edits.

Check out the other tools of *QAD* which allow you e.g. to extent and trim lines, create parallel lines, lengthen lines. There is a lot of helpful stuff.

If all linear objects of the particular object category are digitized, the objects should be saved once more. Finally, the digitization process is finished: Again click Toggle Editing → Save (the yellow pen on the layer disappears).

Laminar objects
Create a new shapefile (see paragraph **Linear objects**). Attention: For laminar objects the Geometry type *Polygon* has to be selected. Choose a distinct name and the correct CRS.

Start the editing mode (Toggle Editing) like it is described for linear objects.

Now use the *Digitizing Toolbar* (next to the yellow pen) to create a new polygon:

Select “Add Polygon Feature” and click the points which describe your polygon (e.g. edge points of the sandbox or a building). Finish the individual object by right click and give it an object id. Several linear objects can be created in one shapefile.

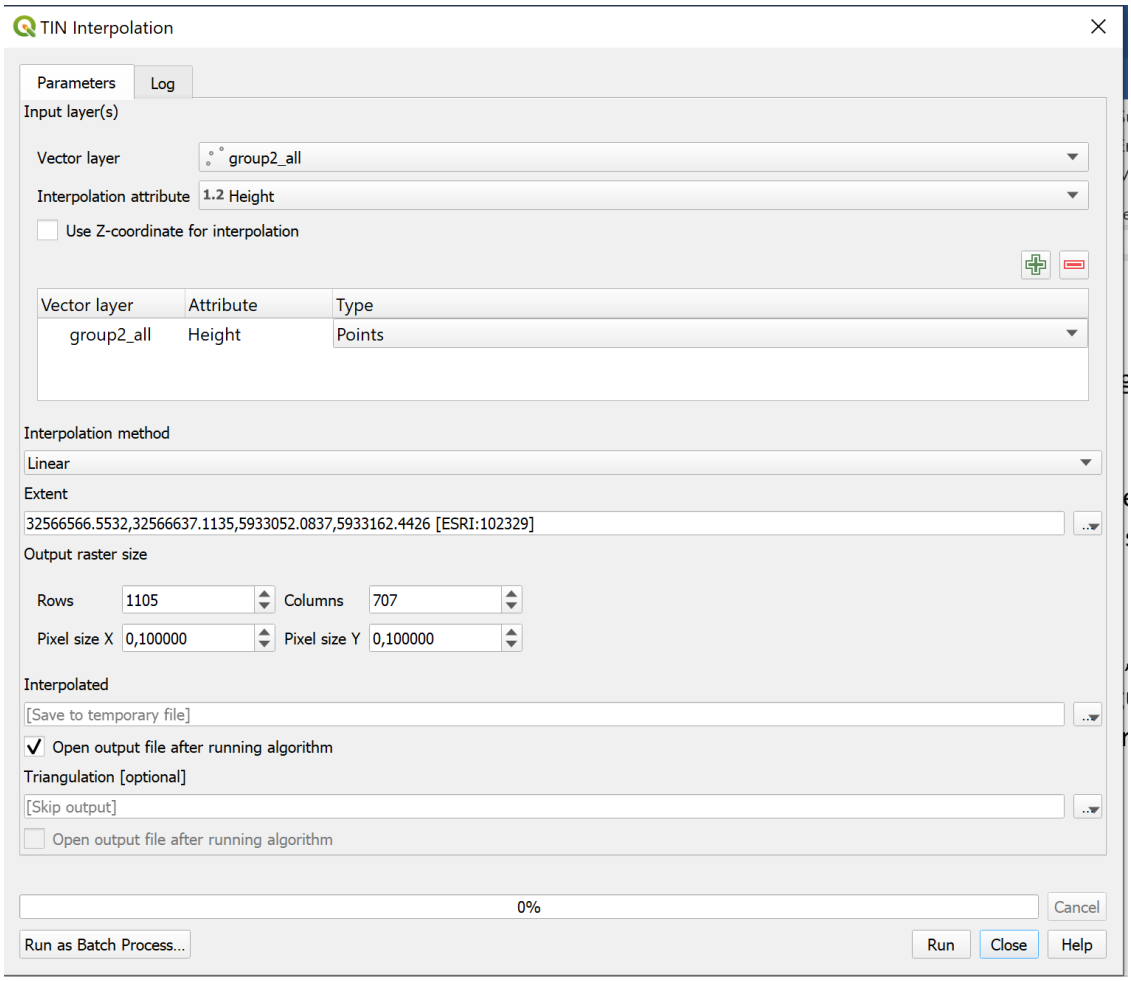
7. To present the created objects in a map adjust the **representation of the linear and laminar** objects. Double click on the individual layers and go to the Symbology. Choose an adequate colour / representation for the particular object category.

In the end you should have a good representation of the scene without displaying any measured points and background maps!

8. To additionally bring some **topographic height information** to the final chart generate contour lines. To get the best overview of the whole scenery calculate them using all measured points (so your initial group file representing all point in one file).

   As contour lines can only be calculated from raster datasets (not from point sets), a DTM (Digital Terrain Model) has to be calculated first. The given dataset consists of view, irregularly distributed points, so a DTM is best represented by a Triangulated Irregular Network (TIN). From such a TIN then a raster can be computed.

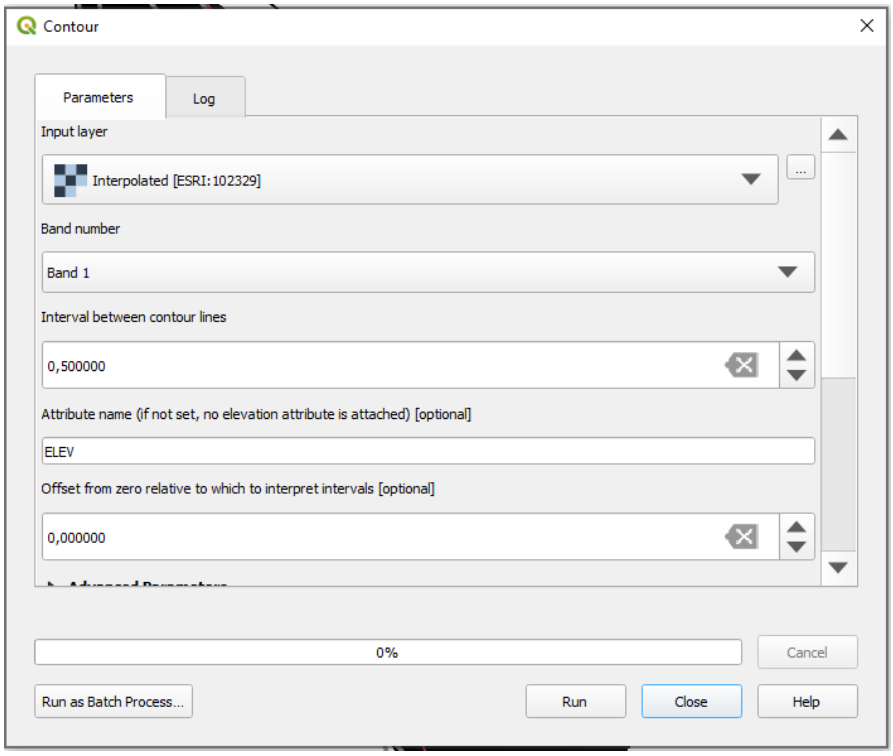
   QGIS offers a tool which calculates both steps at once:
   Go to the Processing Toolbox and search for *TIN interpolation.*
   Select the vector layer of all your points, select as interpolation attribute “Height”, click once the green plus to add the vector layer as input layer, select “Linear” as the Interpolation method, and choose an appropriate extent and raster size. E.g.:



→ Run

A new temporary raster layer gets created.

Now use the *Contour* tool (search for it in the Processing Toolbox) to calculate the contours from the interpolated grid. Choose an appropriate interval between the contour lines and make sure that ELEV (elevation) is set as attribute name:

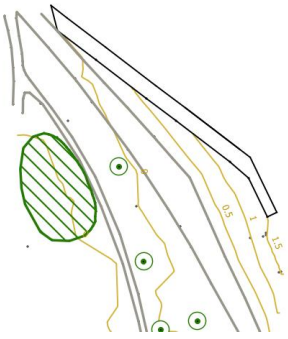


→ Run
→ Save the temporary scratch layer by clicking at the diskette symbol next to the layer as ESRI Shapefile

To smooth the contours use the *Generalizer3* Plugin (search for it in the Plugin manager and install it). Select the Contours as Input line layer and the Mcmaster´s Distance-Weighting Algorithm as Algorithm. Choose appropriate smoothing parameters. → OK. Again: save the new temporary layer as your final contour layer. The other layers can be removed.

Edit the contour lines as before the other line features (see paragraph **Linear objects**) and give them a meaningful symbology. Additionally, add Labels to the contour lines:
In the Layer Properties go to Labels, select “Single Labels” and select “ELEV” as “Value” being displayed. Underneath is a wide variety of label representation offered. Choose appropriate style in terms of colour and placement. You can as well play around with the other representation offers. → OK

Now the representation of the scenery should be satisfying and for example look as this:



9. Creating a **final map layout**:

   Project → New Print Layout
   Give it a name, hit OK and a new window will pop up. This is now the map layout where the final map / layout sketch is being created. The most important items can be found in the left sided panel.
   First of all, add a map of your project: Add map 

   Draw the map extent on the paper and then adjust the maps´ scale in the main properties to an even rounded, appropriate number.
   Now scroll down in the Item properties of your Map and add a frame and a grid if wanted.

   Each map/ layout sketch is required to have a title, a legend, a scale factor or scalebar and, if necessary, additional text information. Generally, a north arrow should also be added.

   Add a title: Left panel → Add label  → Type in your title. The position of the title can be changed by clicking on the title and moving it. In the item properties the Font and size can be adjusted.

   Add additional text (e.g. author, date, chart datum, data source, …): left panel → Add label.

   Add a scalebar: Left panel → Add Scale Bar  → choose appropriate properties.

   Add a north arrow: Left panel → Add North Arrow  → choose appropriate properties.

   Add a legend: Left panel → Add Legend  . Go to the item properties, give the legend a title and go down to the legend items. Tick the box “Only show items inside linked map” and untick “Auto update” to be able to rename your displayed layers in the legend. Edit the legend.

10. **Export the map**:

    Click in the upper panel “Export as pdf…”  and choose a name and file destination.

    The PDF Export Options can be left as default → Save.

    Open your pdf and check the resulting map!

    The final map can also be exported as image in different file formats, choose the export format fitting best for your deliverables.