Anna Gazda, Kamil Kędra

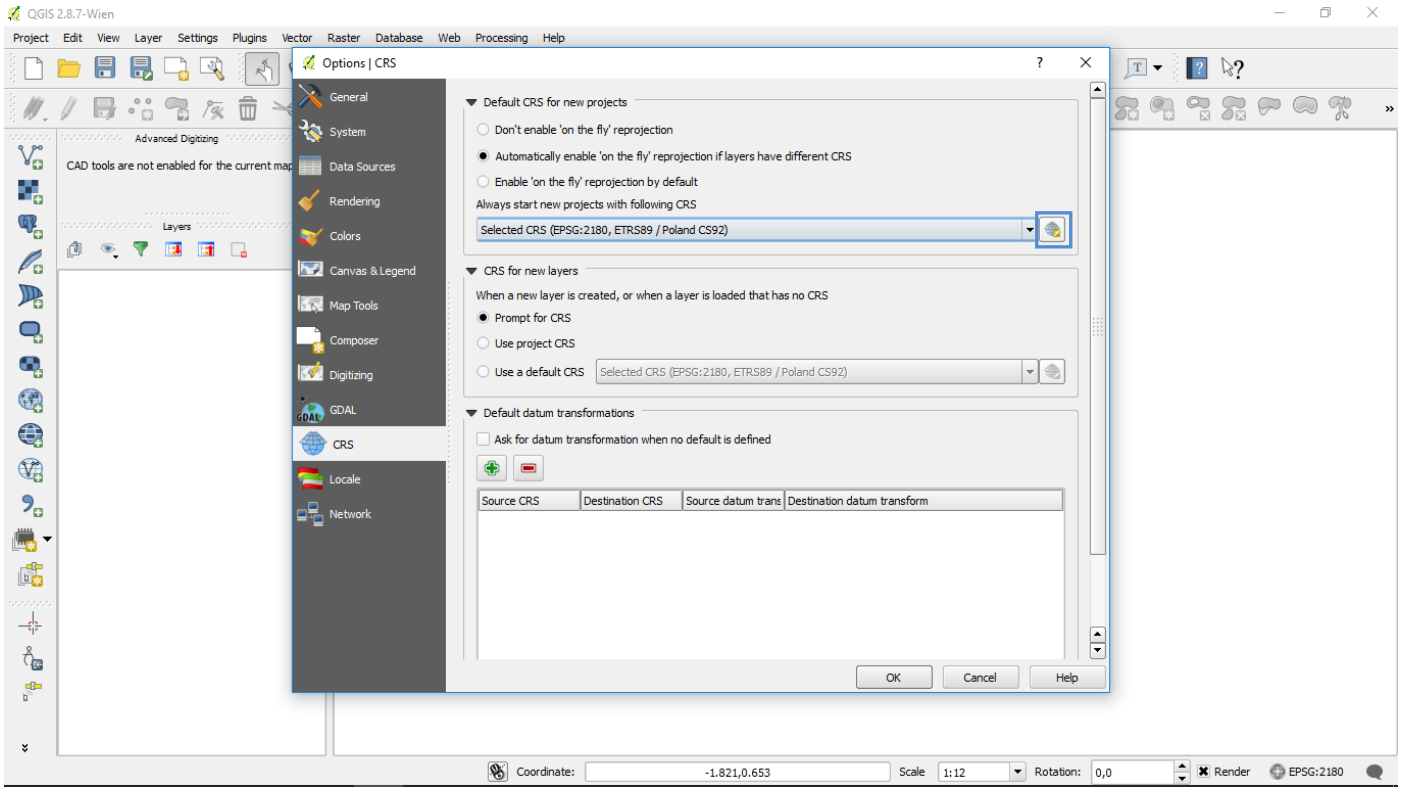
Contents



Note: along the text, links to the related parts of the user manual for QGIS v. 2.8 (http://docs.qgis.org/2.8/en/docs/) were provided.

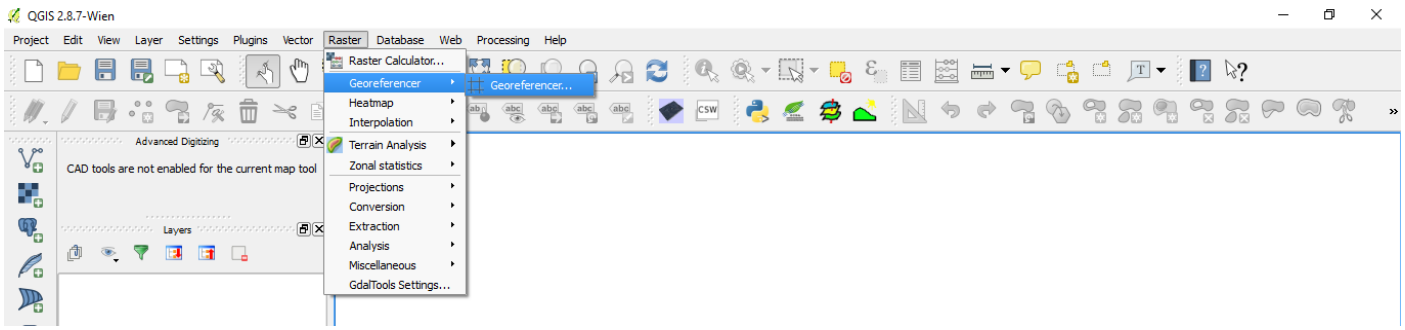
## I Turning a non-metric into a metric image (orthophotograph)

1. Select a projected coordinate system (like a UTM zone) – expressed in units of length; here, we use EPSG:2180 (coordinates given in meters). Settings > Options > CRS: http://docs.qgis.org/2.8/en/docs/user_manual/working_with_projections/working_with_projections.html

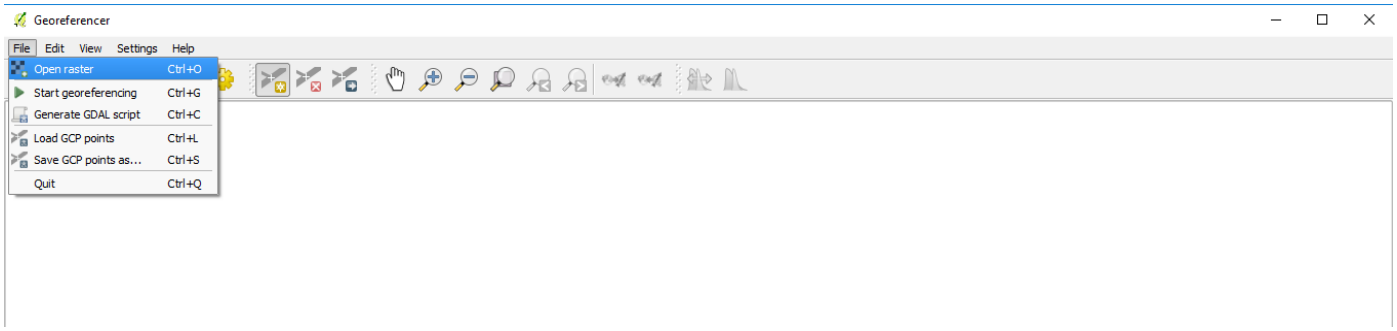


2. Select the Georeferencer tool: Raster > Georeferencer > Georeferencer...:

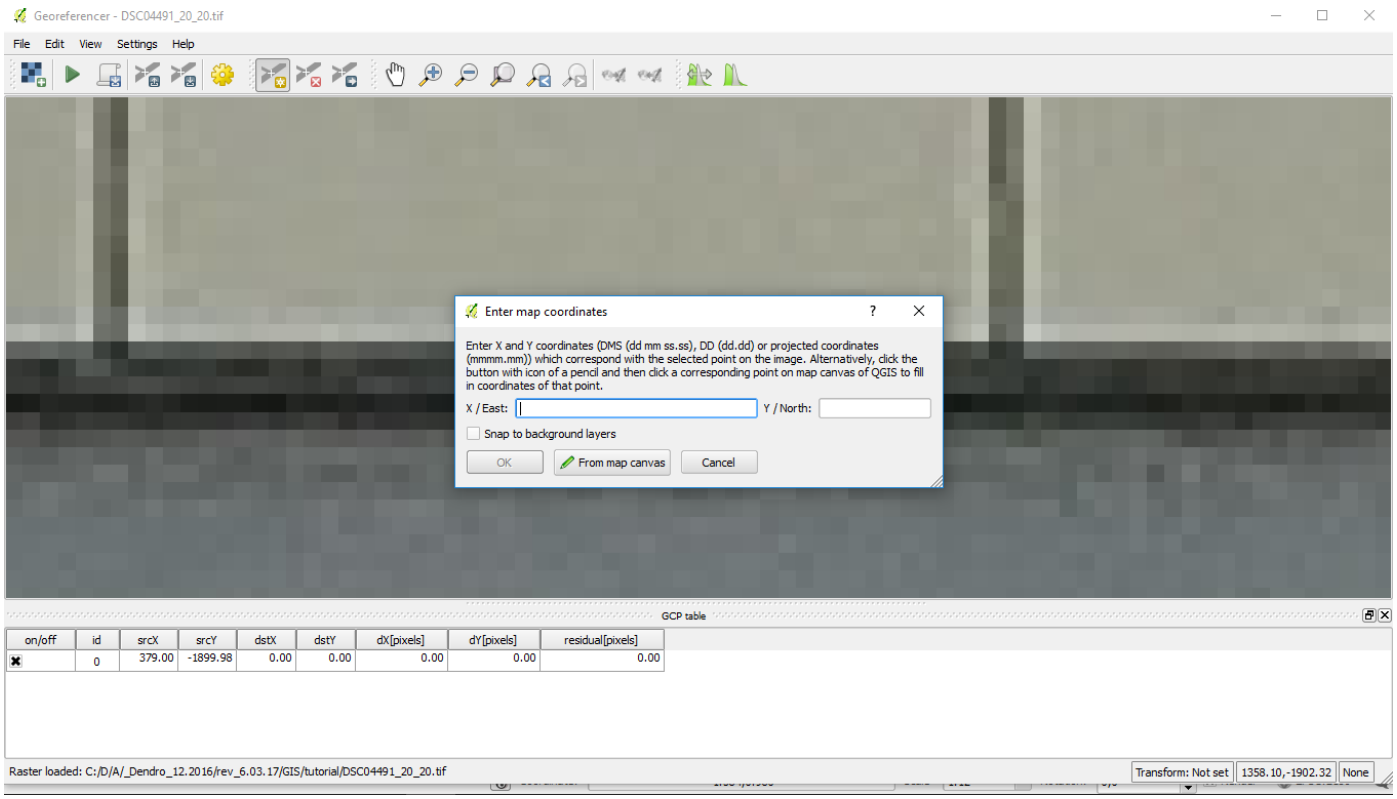
http://docs.qgis.org/2.8/en/docs/user_manual/plugins/plugins_georeferencer.html

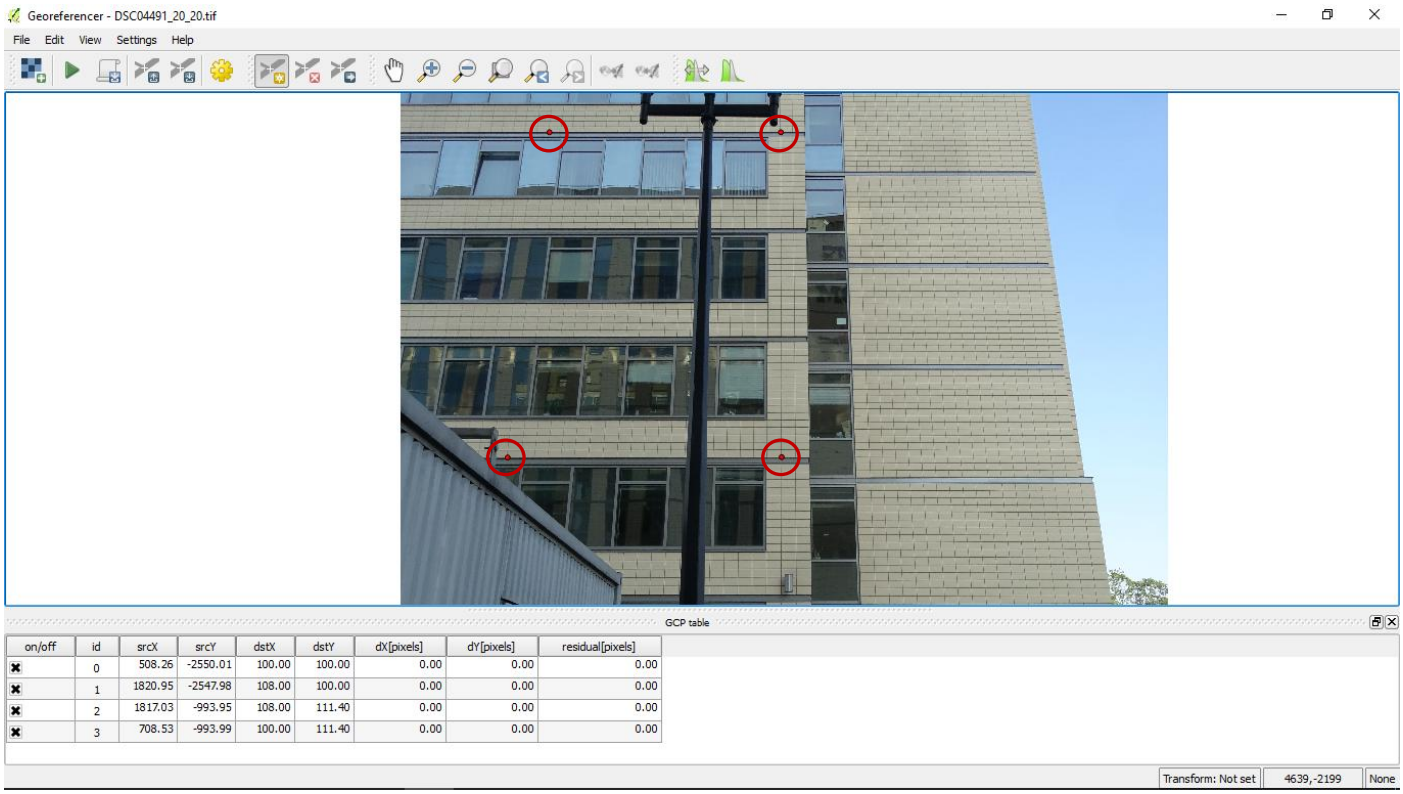



3. Open image of the reference object: File > Open raster:



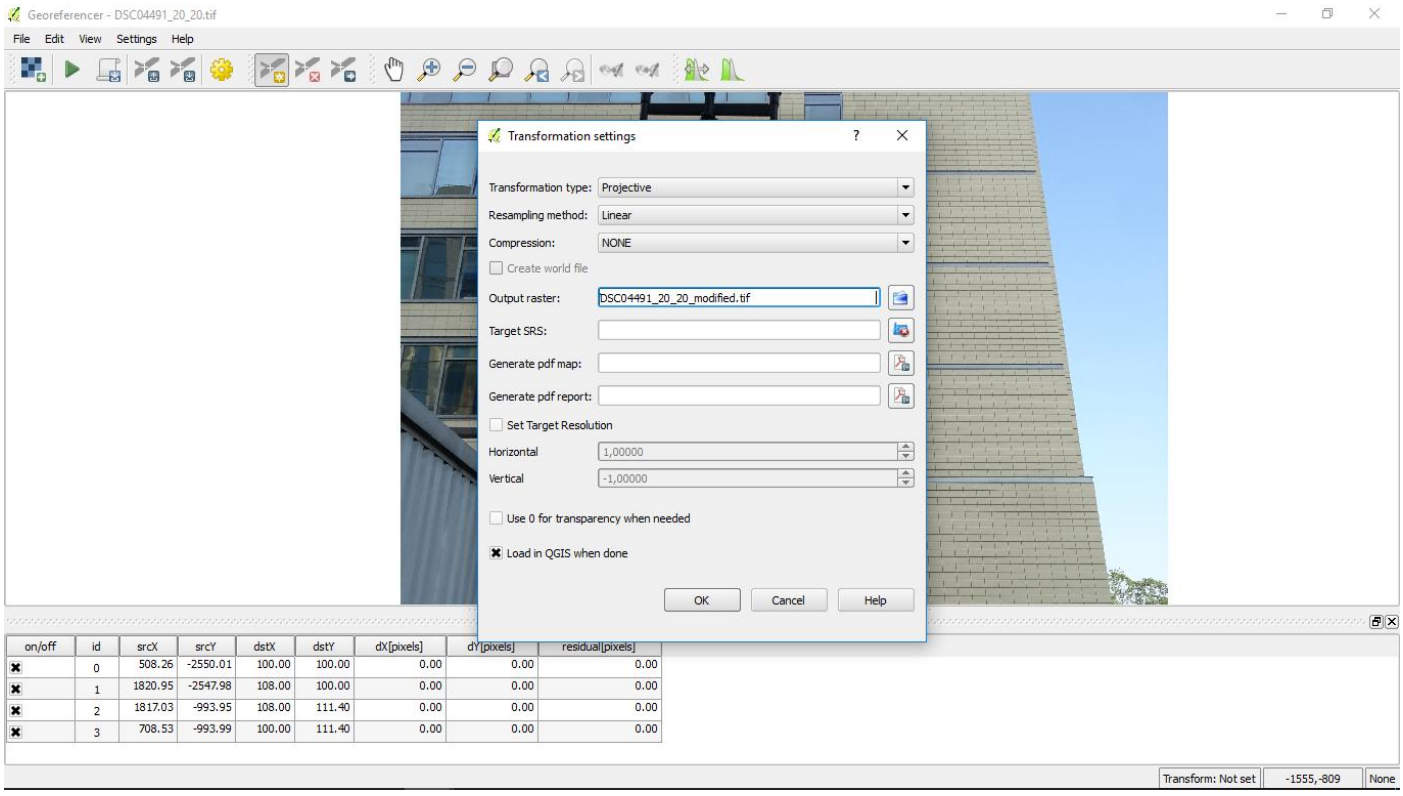

4. Add four control points and enter the measured X,Y coordinates in meters.





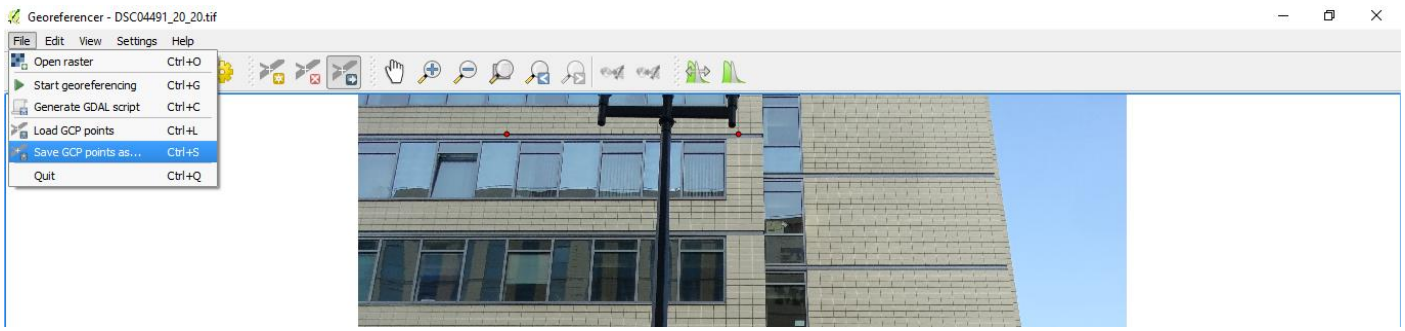

| on/off | id | srcX | srcY | dstX | dstY | dX[pixels] | dY[pixels] | residual[pixels] |
|---|---|---|---|---|---|---|---|---|
| ✖ | 0 | 508.26 | -2550.01 | 100.00 | 100.00 | 0.00 | 0.00 | 0.00 |
| ✖ | 1 | 1820.95 | -2547.98 | 108.00 | 100.00 | 0.00 | 0.00 | 0.00 |
| ✖ | 2 | 1817.03 | -993.95 | 108.00 | 111.40 | 0.00 | 0.00 | 0.00 |
| ✖ | 3 | 708.53 | -993.99 | 100.00 | 111.40 | 0.00 | 0.00 | 0.00 |

5. Start georeferencing (Ctrl+G), set the Transformation settings: Transformation type – Projective, Resampling method – Linear, and give the name for the Output file; mark ‘Load in QGIS when done’.

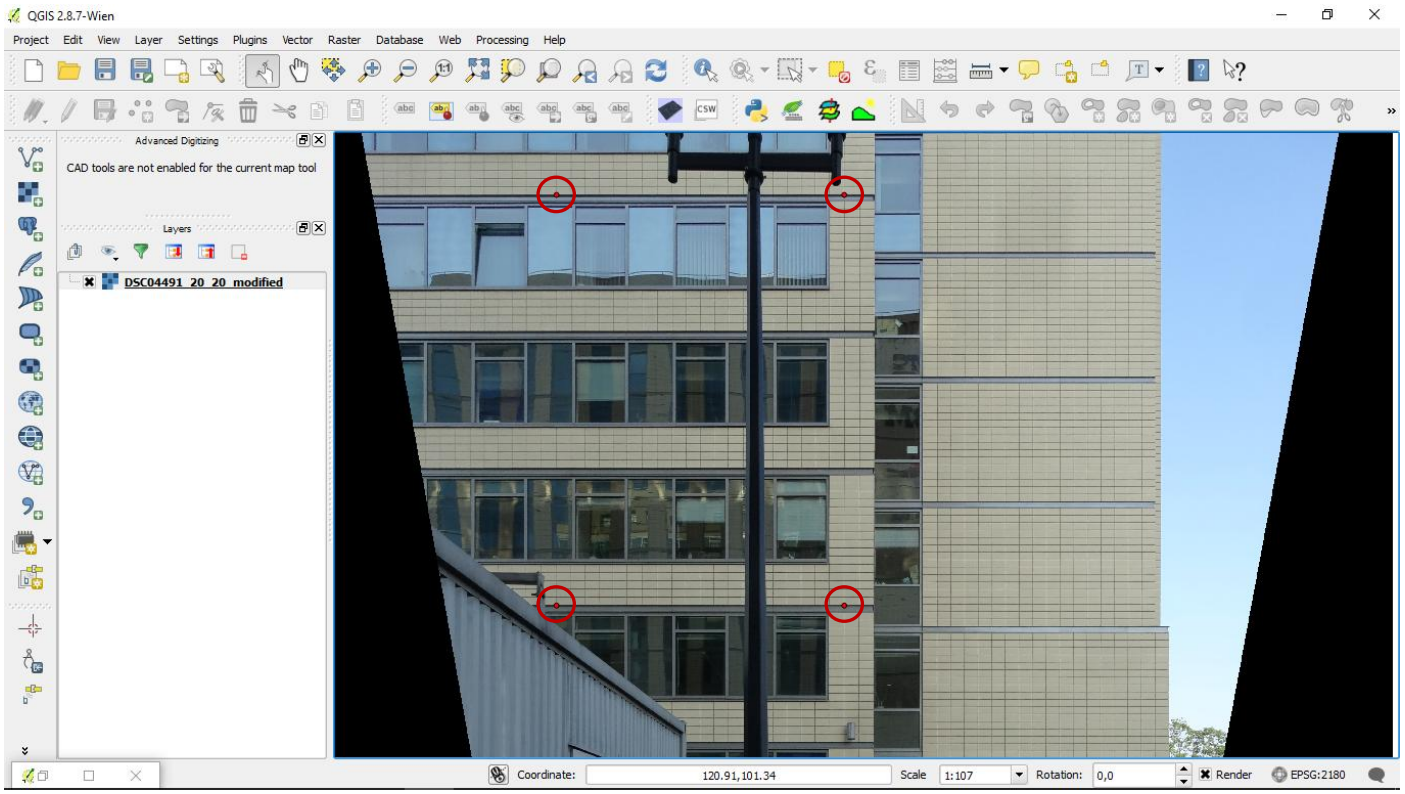



| on/off | id | srcX | srcY | dstX | dstY | dX[pixels] | dY[pixels] | residual[pixels] |
|---|---|---|---|---|---|---|---|---|
| ✖ | 0 | 508.26 | -2550.01 | 100.00 | 100.00 | 0.00 | 0.00 | 0.00 |
| ✖ | 1 | 1820.95 | -2547.98 | 108.00 | 100.00 | 0.00 | 0.00 | 0.00 |
| ✖ | 2 | 1817.03 | -993.95 | 108.00 | 111.40 | 0.00 | 0.00 | 0.00 |
| ✖ | 3 | 708.53 | -993.99 | 100.00 | 111.40 | 0.00 | 0.00 | 0.00 |

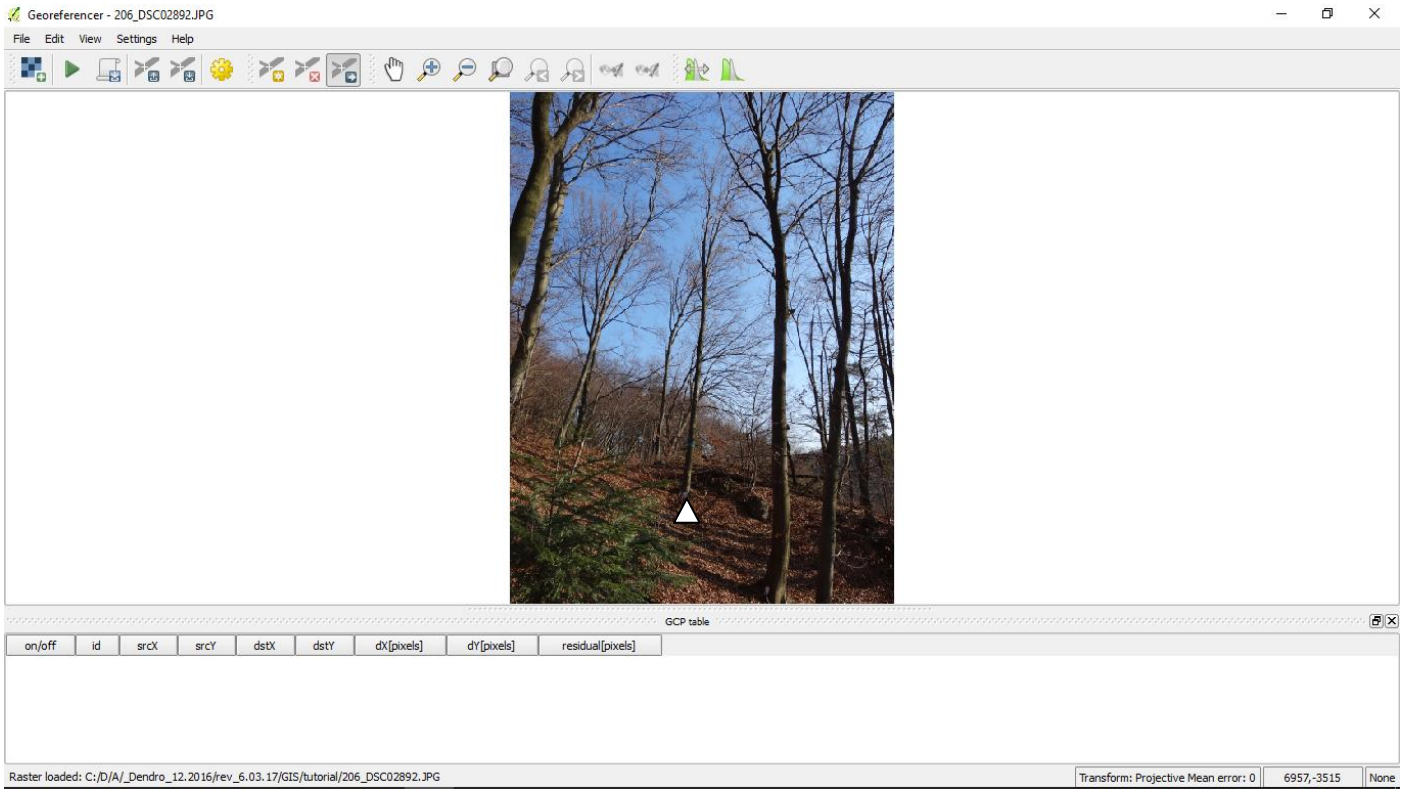
6. Save the GCP points to your disc: File > Save GCP points as...:



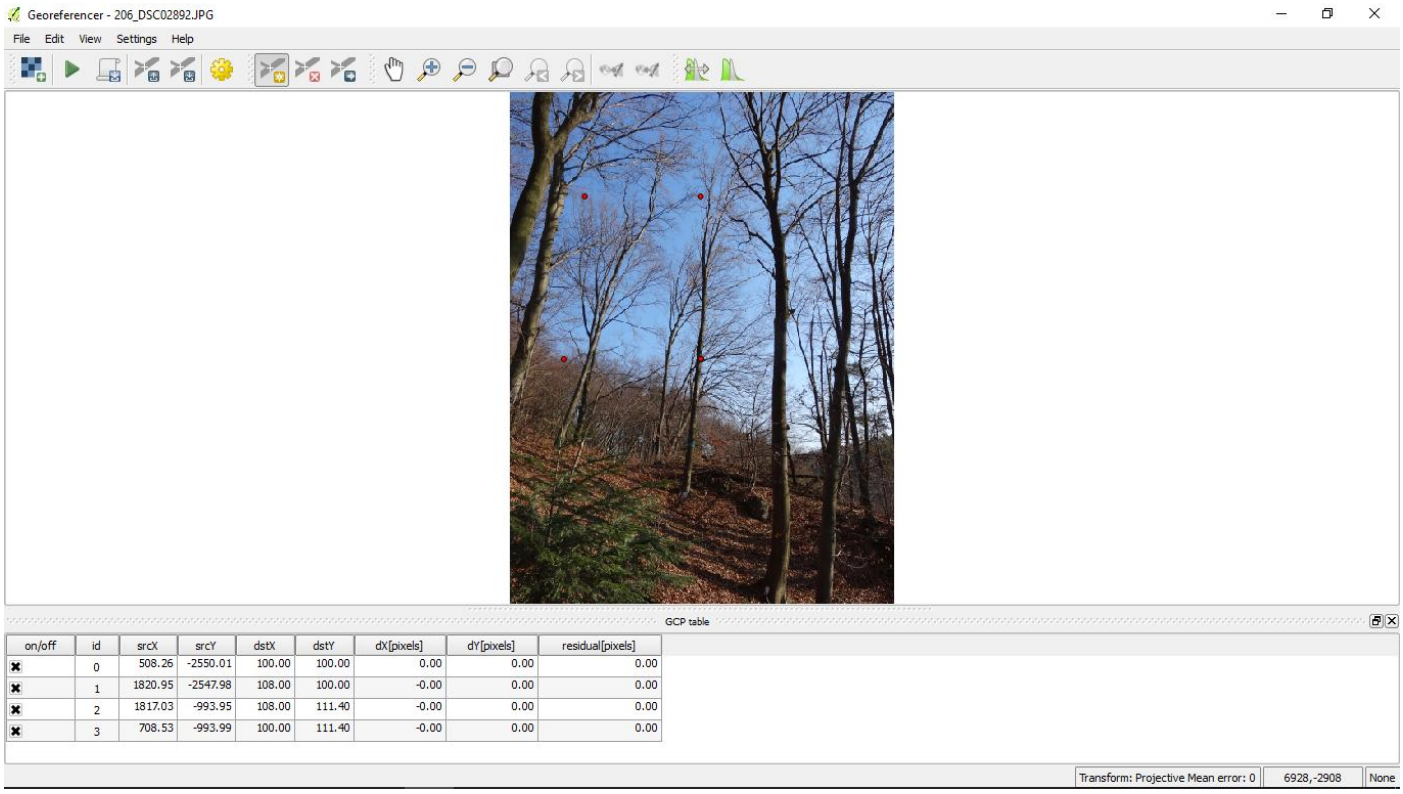

7. After closing the Georeferencer widow you can see the transformed image in QGIS main window.



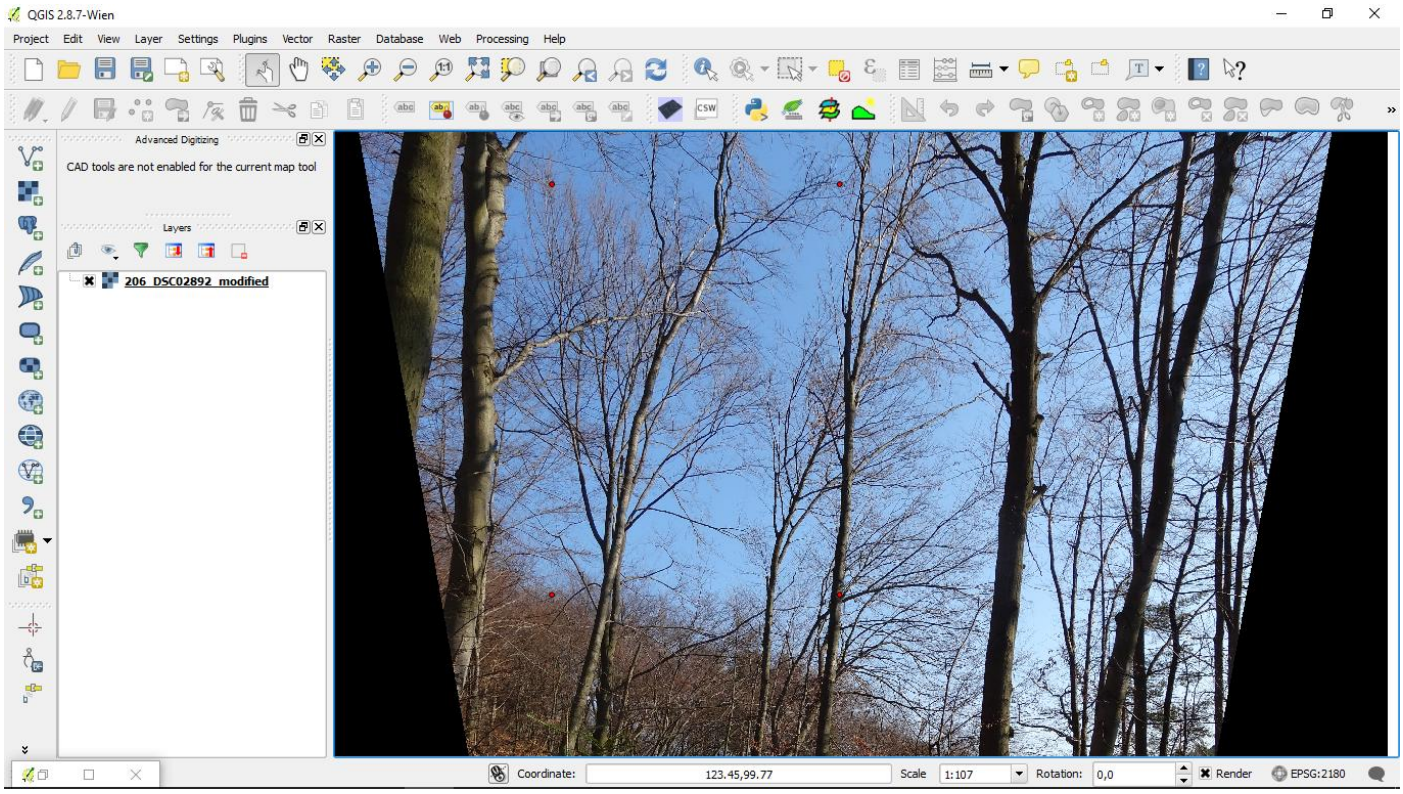

8. Open the Georeferencer tool again and open the image of a tree (as in 3.). The target tree here is marked with a triangle.




9. Load the saved control points: File > Load GCP points:




10. Start georeferencing (as in 5.), repeat steps 8-10 for every image taken with the same camera settings (in this example the camera distance was 20 m and camera angle (tilt) was 20°).

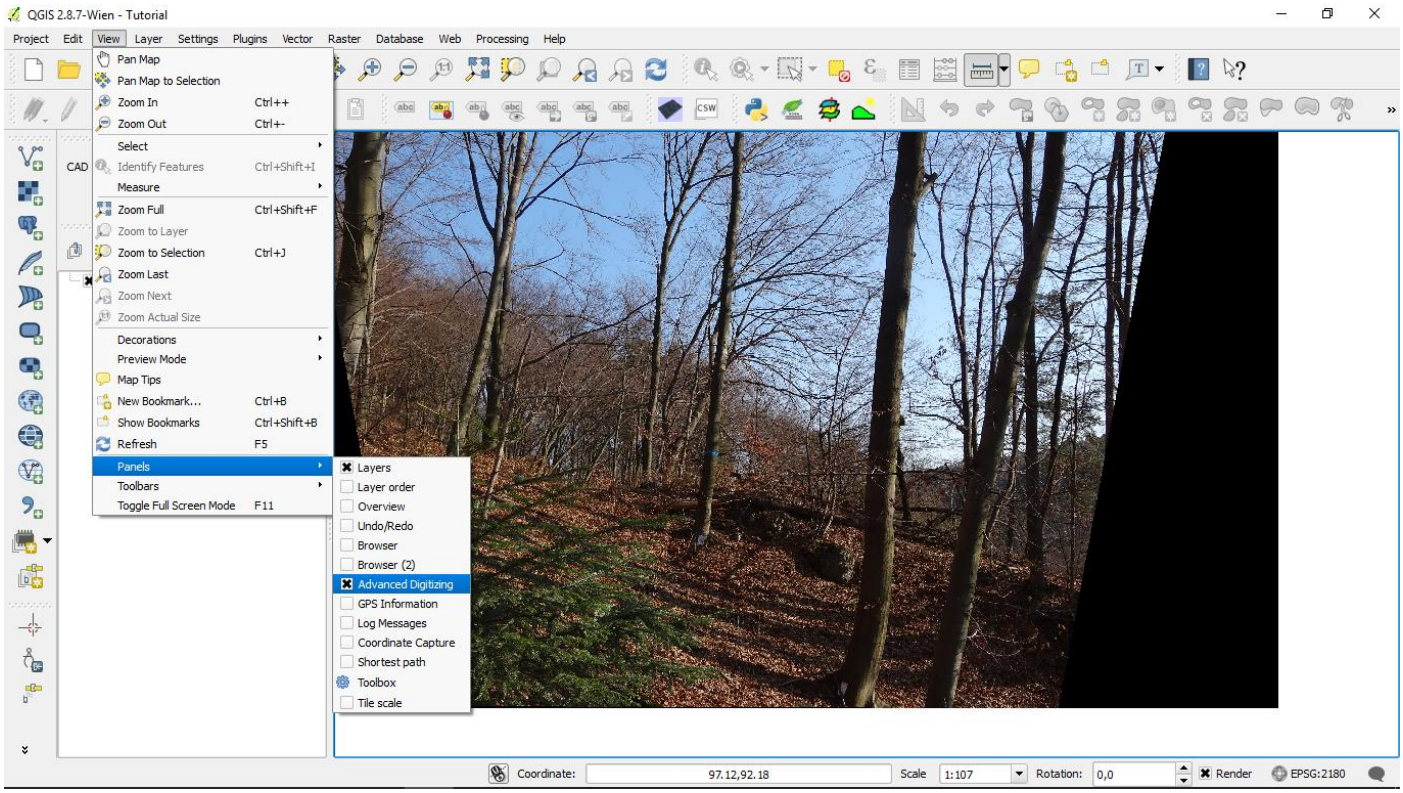



Note: if the coordinates of the tree position are known, you may use the Georeferencer tool again to match the transformed image with the actual place. This can be done by using a simpler transformation type, like Helmert, which requires at least two control points, e.g., assuming that the image's lower left corner fits the location of the target tree and the lower right corner is the second control point (the exact image dimensions may be found with: Raster > Miscellaneous > Information...).

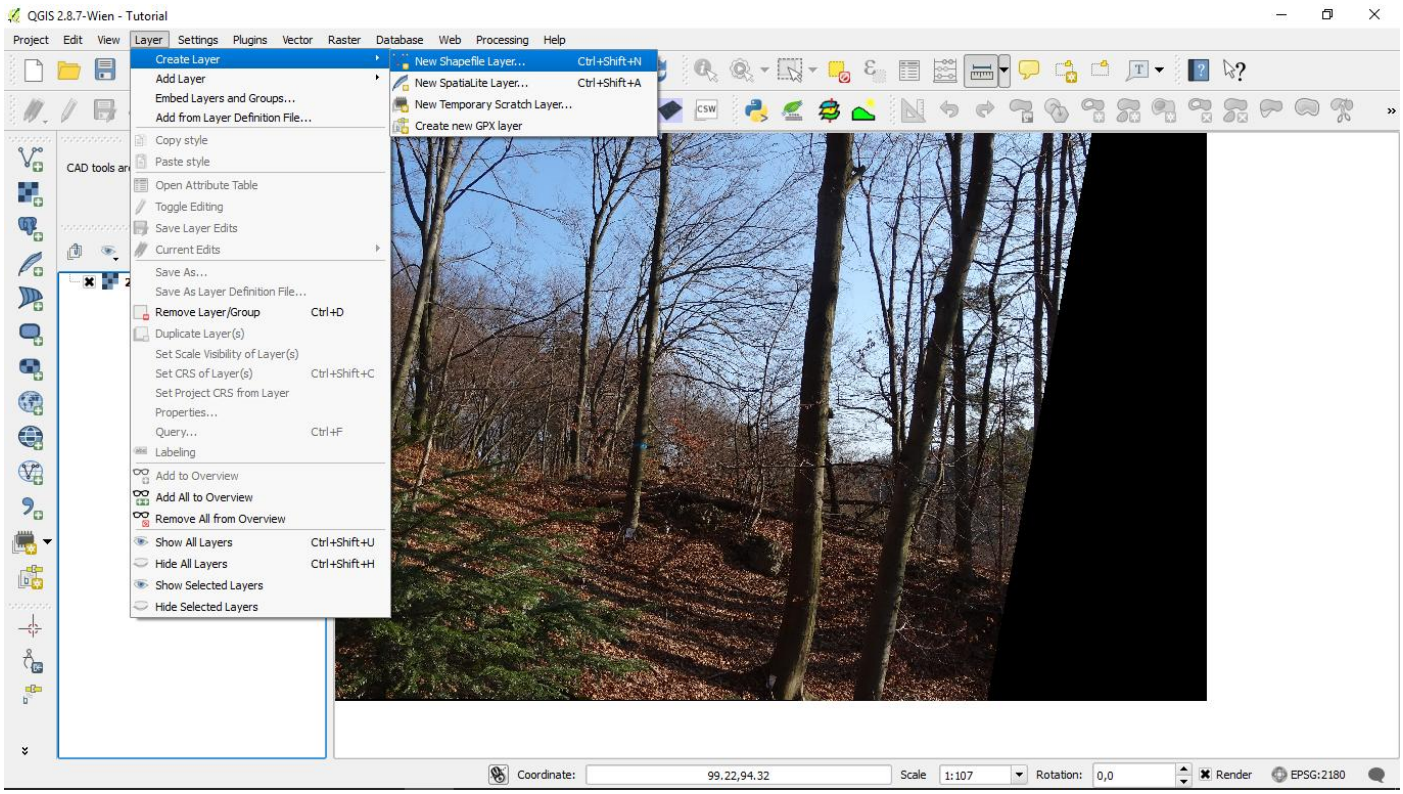
## II Defining tree traits dimensions

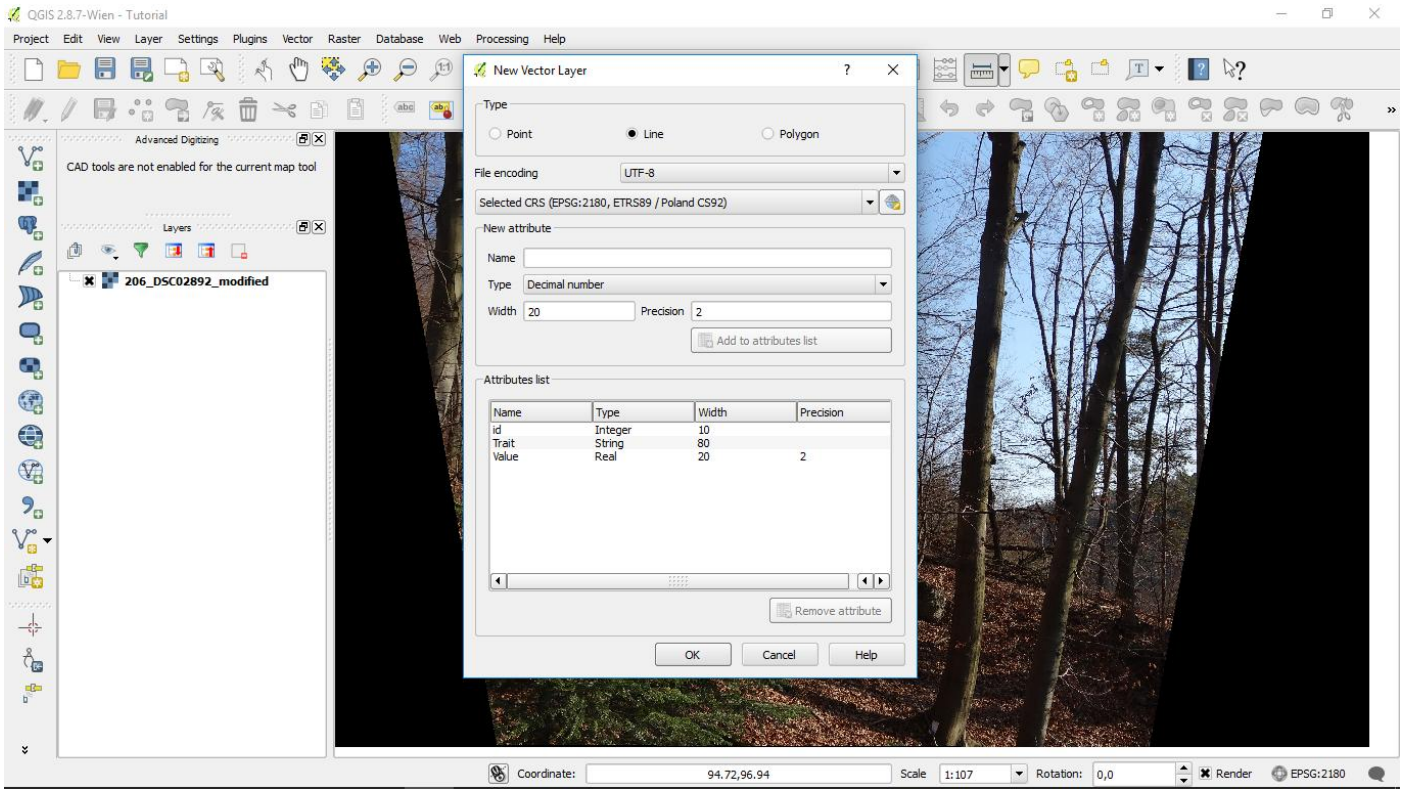
The image is scaled and ready for taking measurements. The time consumption of this part is strictly connected to the range of data needed. In this tutorial we will show how to measure DBH, vertical crown projection area (CPA), tree height (H), two opposite crown radii (CR1, CR2) and crown length (CL).

1. Make sure the Advanced Digitizing tools are on: View > Panels > Advanced Digitizing. Please refer to the QGIS manual for the description of working with vector data: http://docs.qgis.org/2.8/en/docs/user_manual/working_with_vector/index.html

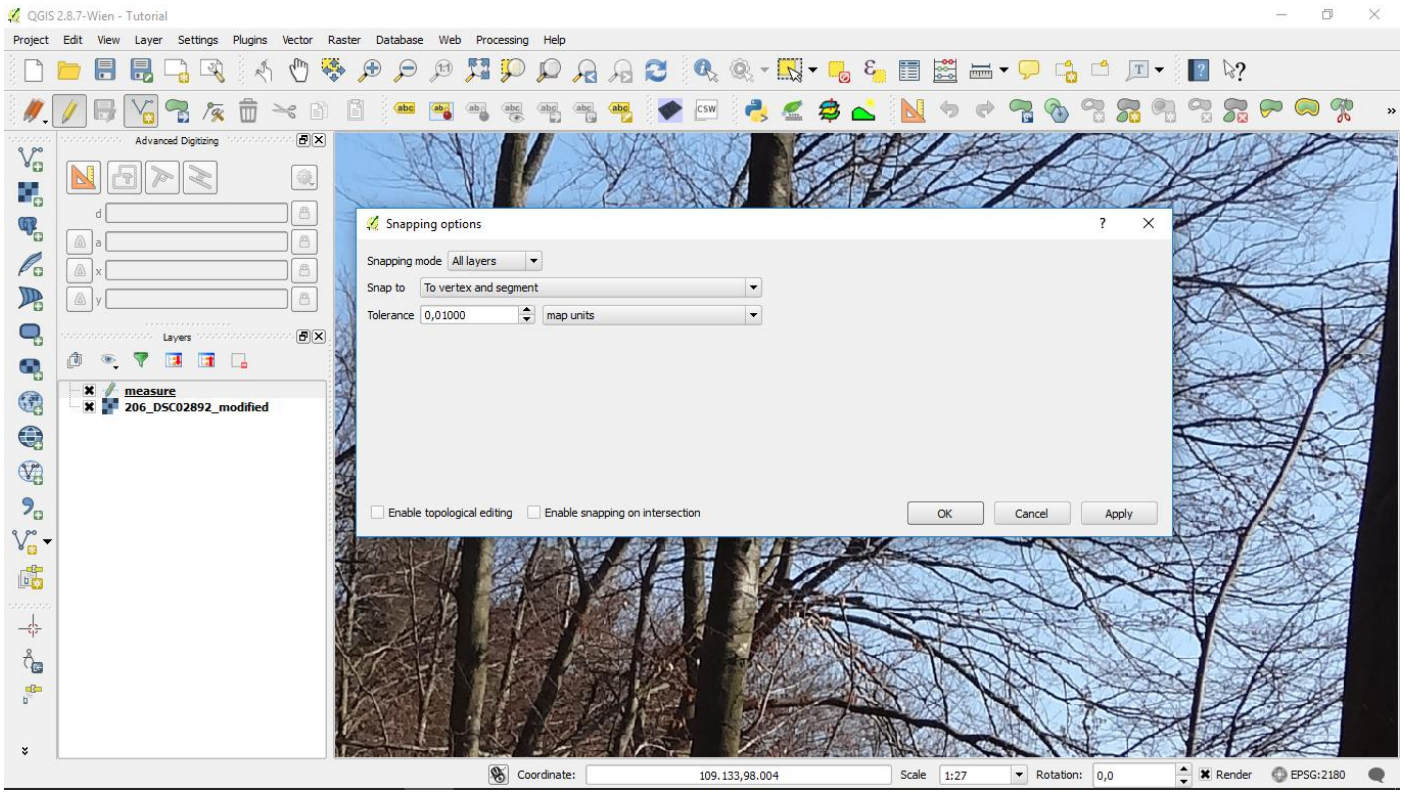



2. Create a vector layer ‘measure’: Layer > Create Layer > New Shapefile Layer... In the New Vector Layer widow select Type – Line, and add two New Attributes: (i) Name – Trait, Type – Text data, Width – at least three characters; (ii) Name – Value, Type – Decimal number, Width – three, Precision – two.

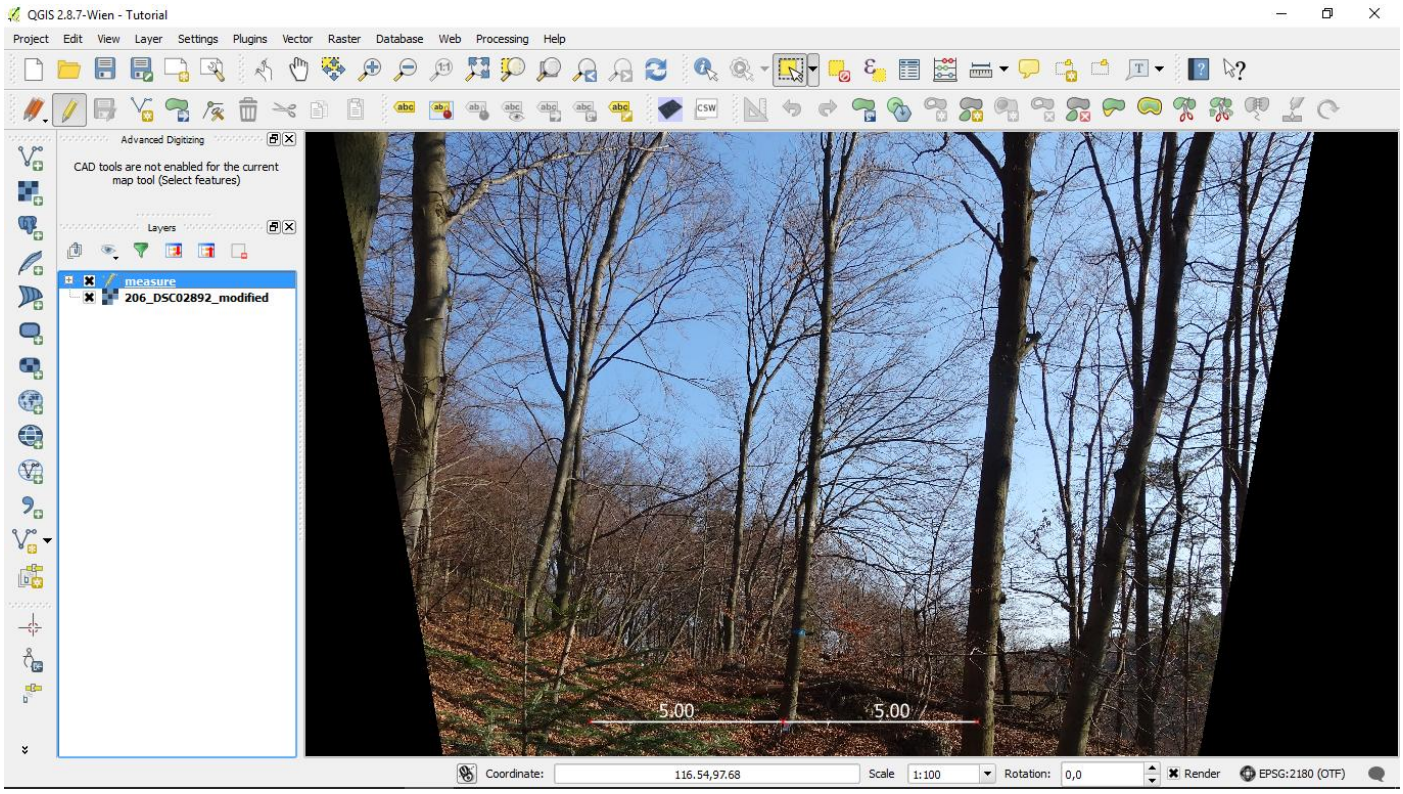




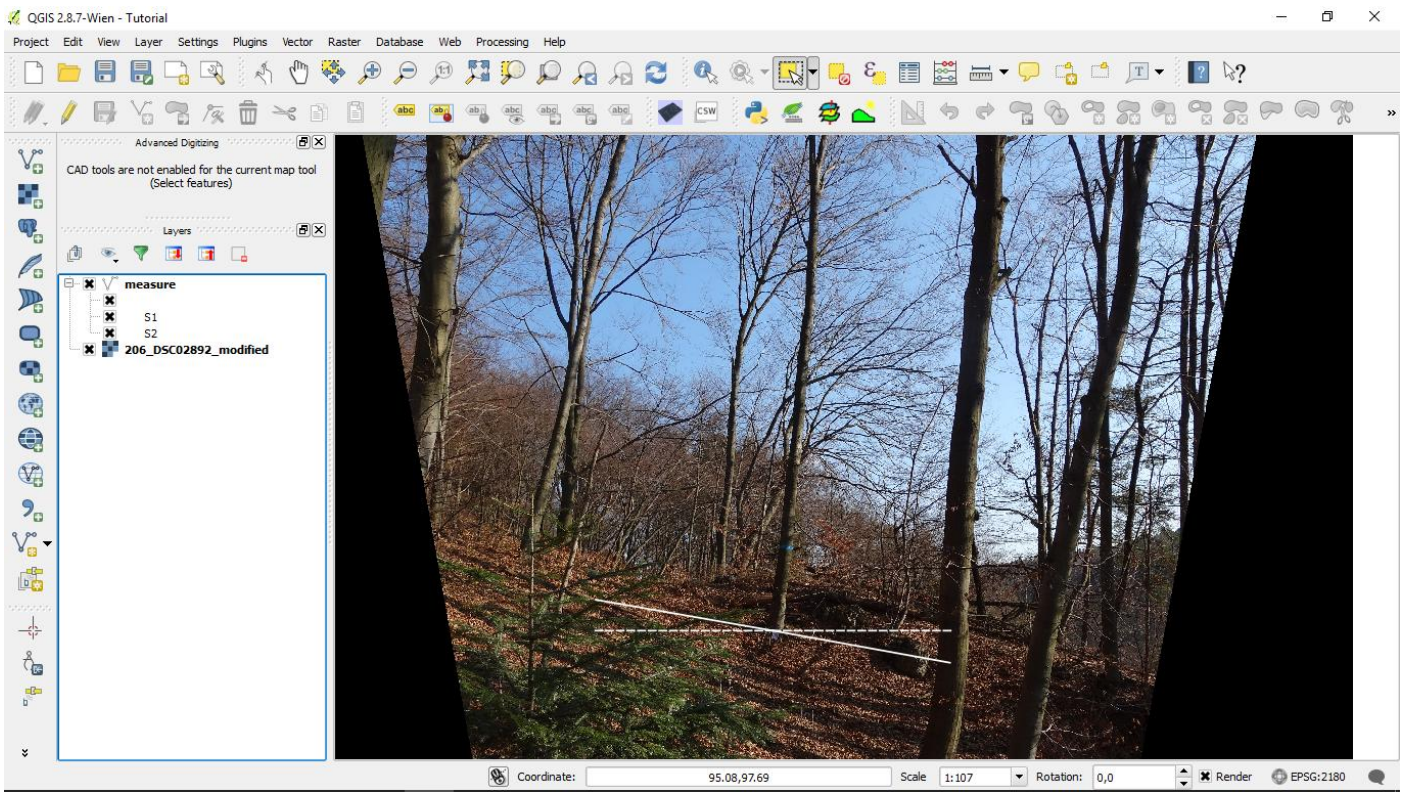

3. Turn on Snapping, this will allow you to digitize more accurately, starting new line from any existing line segment or vertex: Settings > Snapping Options. You may try different settings, e.g., snapping to segments only or to vertices and segments, and with different Tolerance (here the tolerance is set to 1 cm).



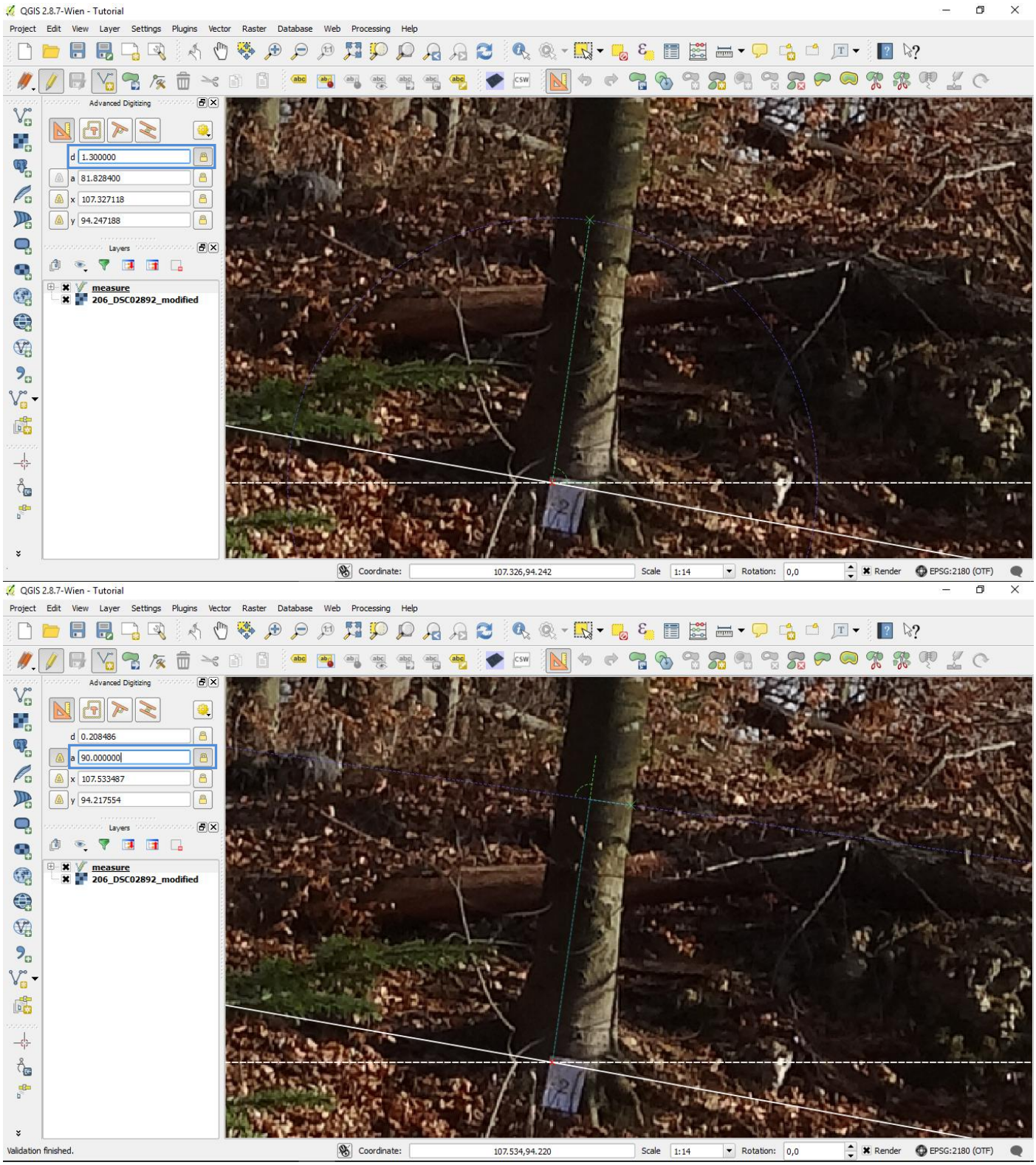
4. Highlight the ‘measure’ layer, enable the editing mode (Layer > Toggle Editing) and add two horizontal lines (e.g. 5 m long each) to define the tree base (Add Feature icon in the Digitizing Toolbar).

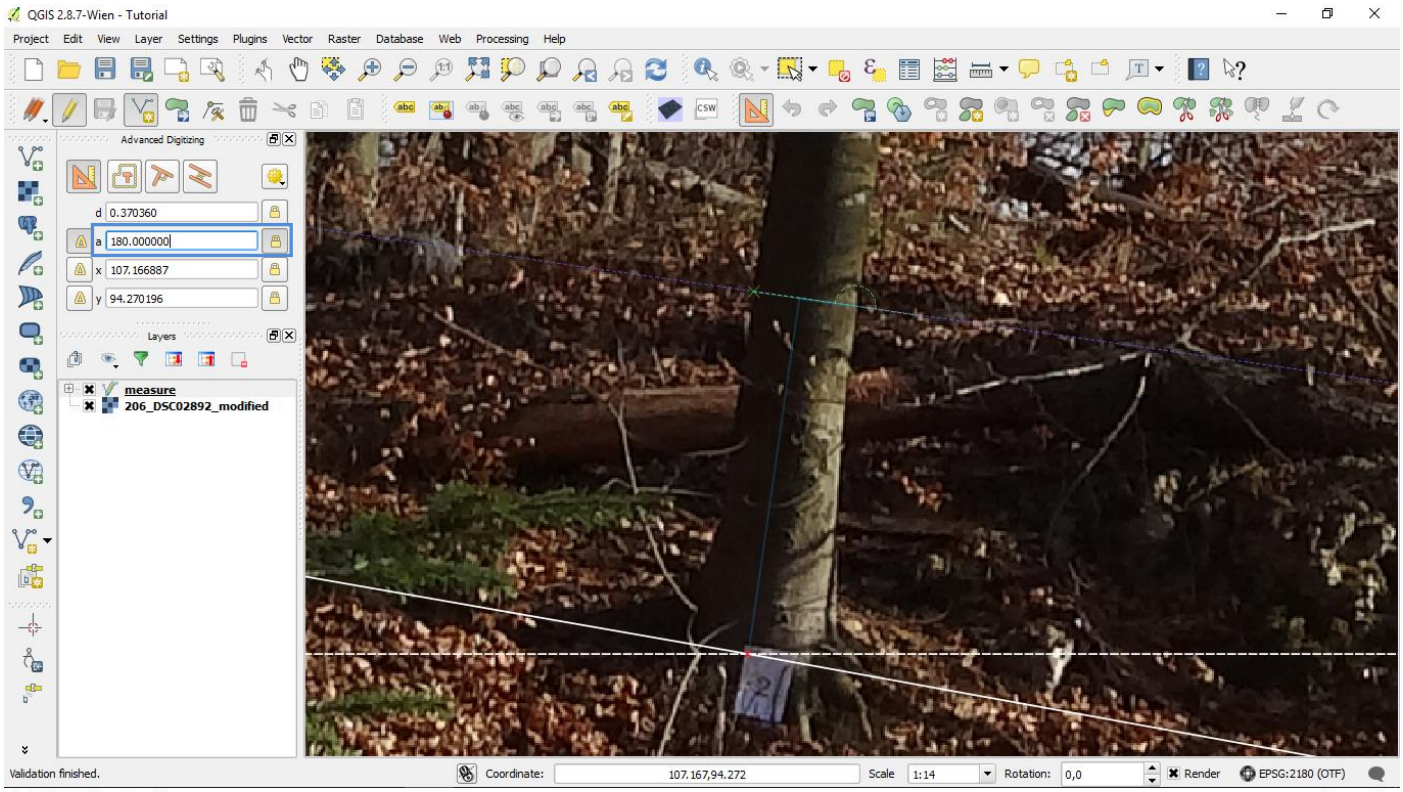


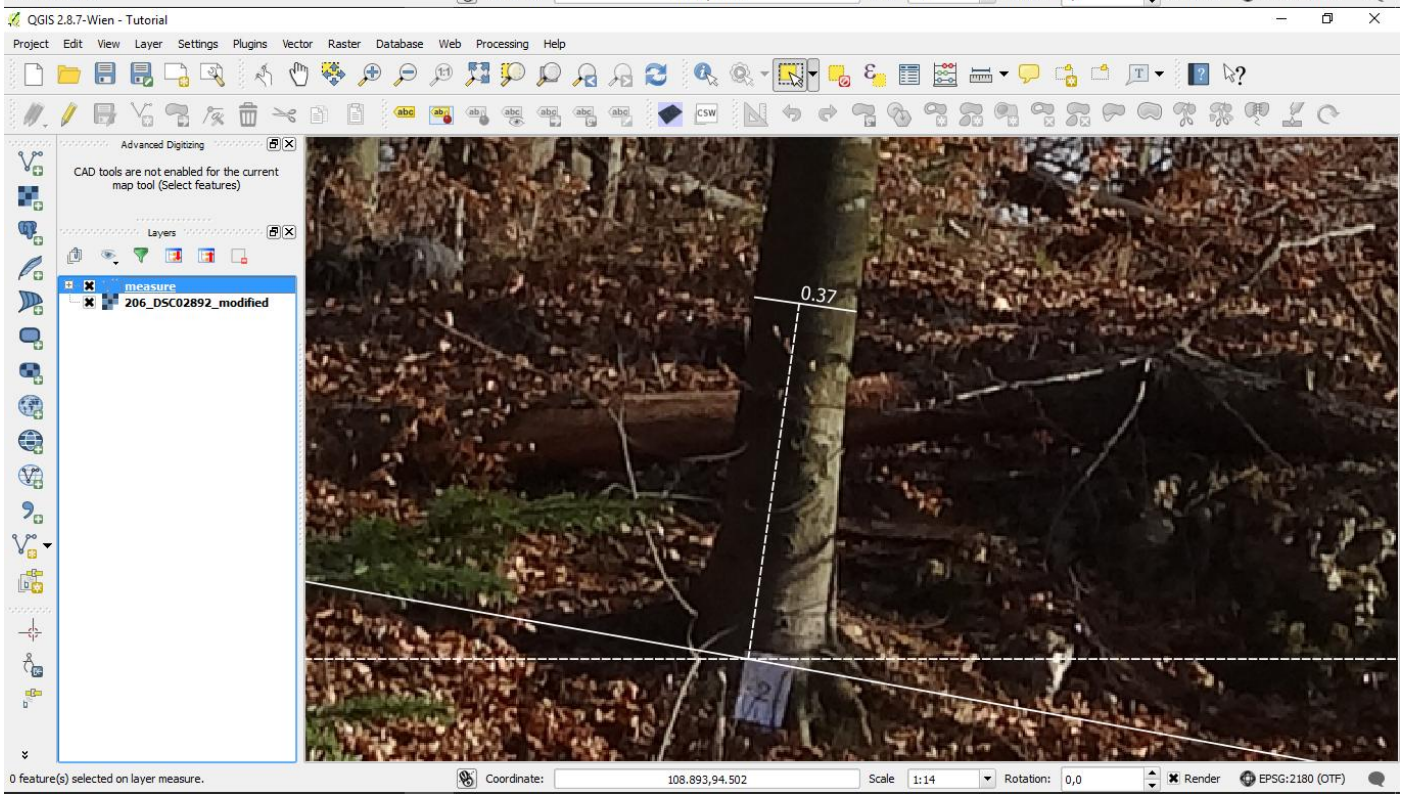

Note: If the terrain slope is noticeable, comparing to the horizontal lines, you may visually align new lines to represent the slope:



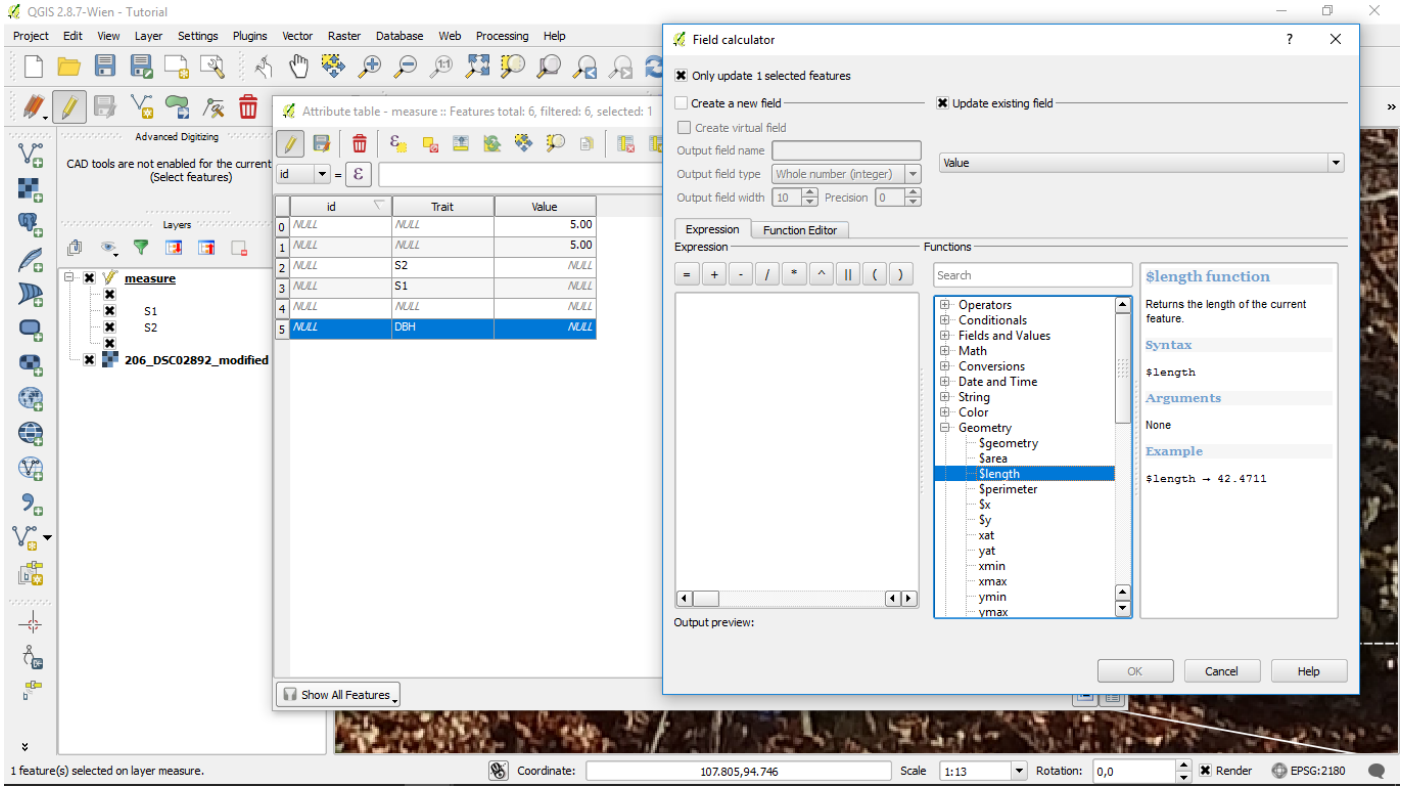
5. To measure tree DBH draw a line (1.3 m long) from stem base, and fit another one to the trunk diameter at 1.3 m, as shown below:



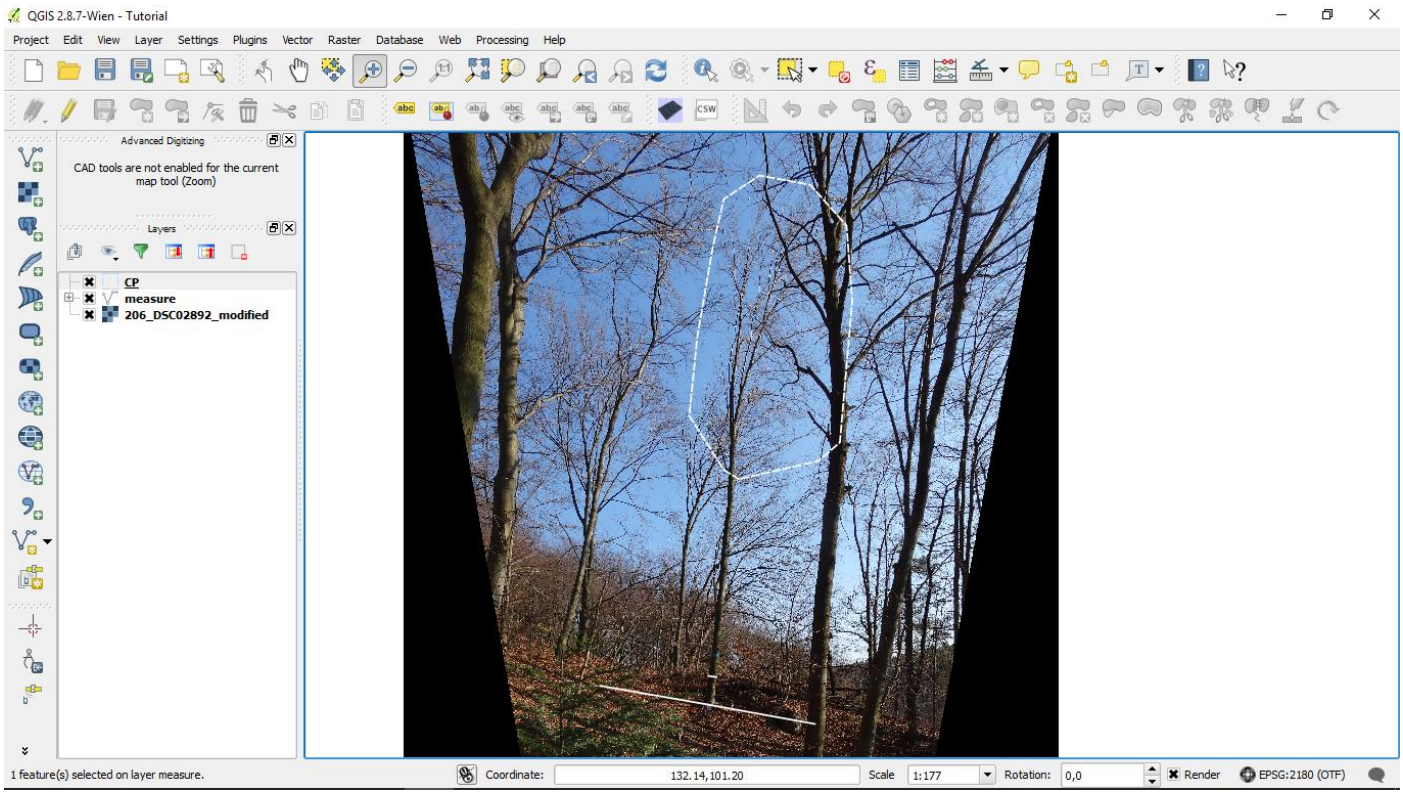


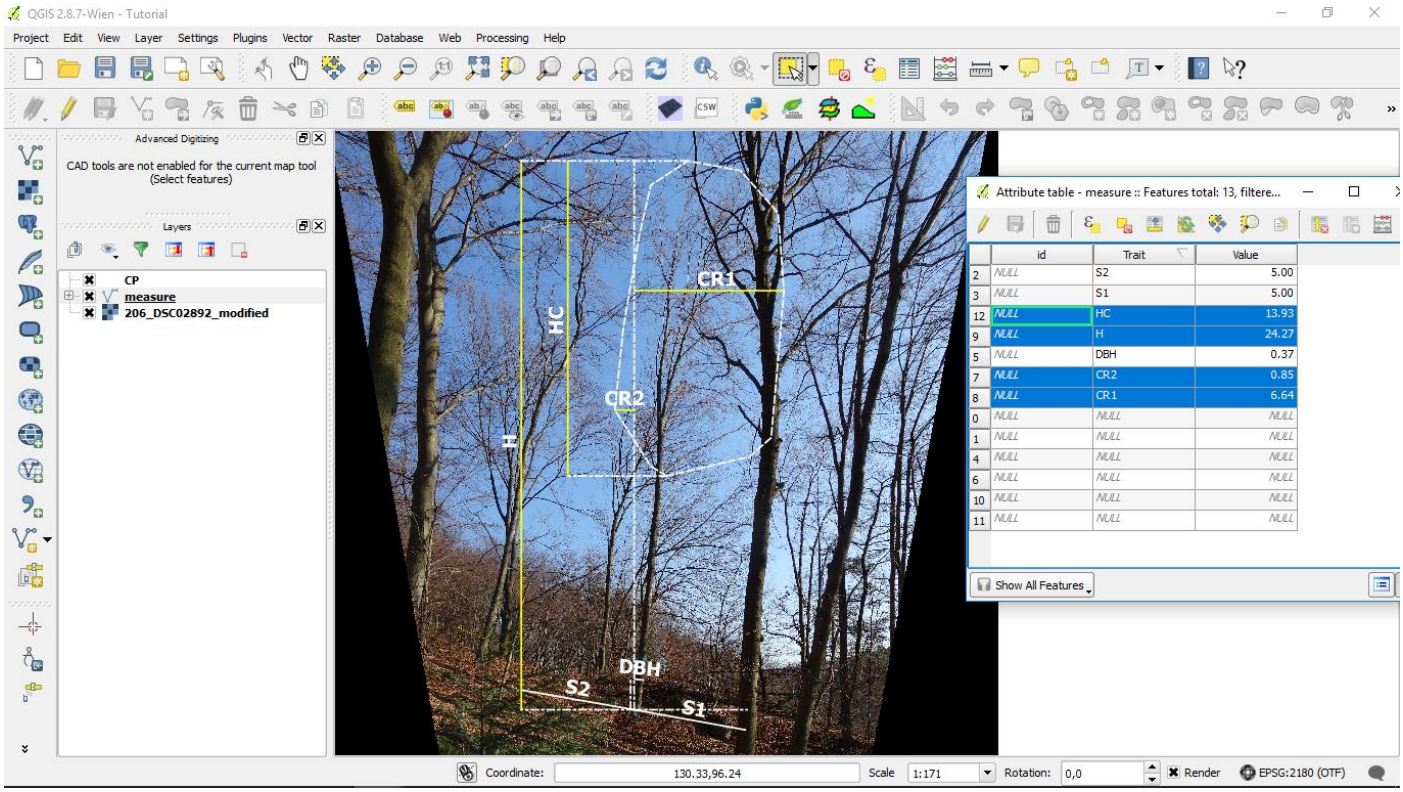

Note: DBH here is 37 cm; this was measured automatically with the Field calculator by updating the selected feature and existing field (Value); function = $length: Layer > Open Attribute Table > Open field calculator (the layer should be highlighted, with the editing mode turned on): http://docs.qgis.org/2.8/en/docs/user_manual/working_with_vector/field_calculator.html




6. Create a vector layer ‘CP’, similarly as in 2. but select Type – Polygon. Enable editing and select Add Feature. Find the first branch and start digitizing the envelope of the crown (vertical crown projection) by going around the crown and sampling the visible, furthermost parts of the branching system; here represented as a convex hull. The vertical crown projection area may be measured with the Field calculator, similarly as shown above for DBH, but the function would be ‘$area’.



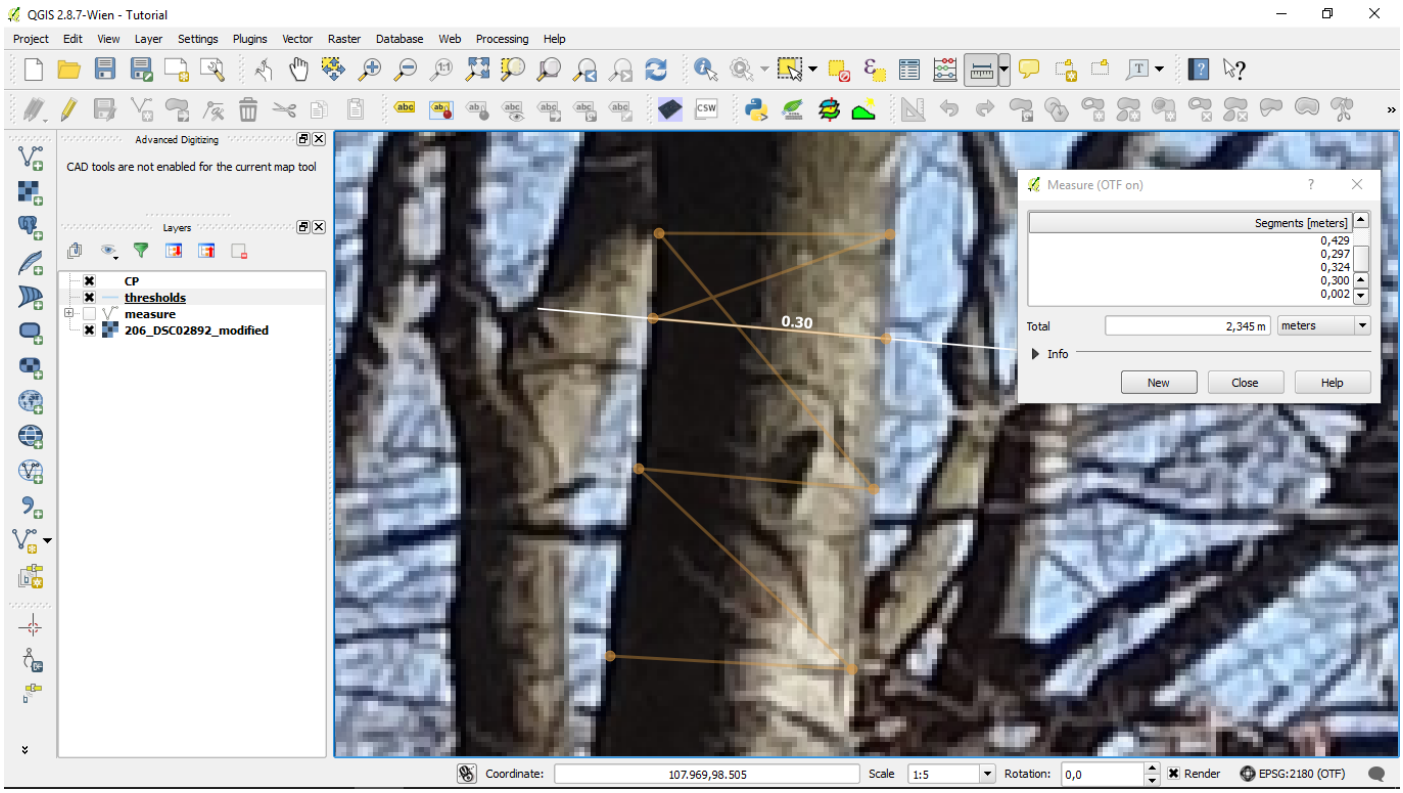
7. Highlight the ‘measure’ layer, enable editing, and add vertical and horizontal lines representing size of the measured traits or serving as guidelines, as shown below. Next, open the Attribute table of the ‘measure’ layer, highlight selected features and update their values with the Field calculator (function = $length). Here, we have measured: tree height (H = 24.27 m), length of the crown (CL = 13.93 m), and two opposite crown radii (CR1 = 6.64 m, CR2 = 0.85 m).

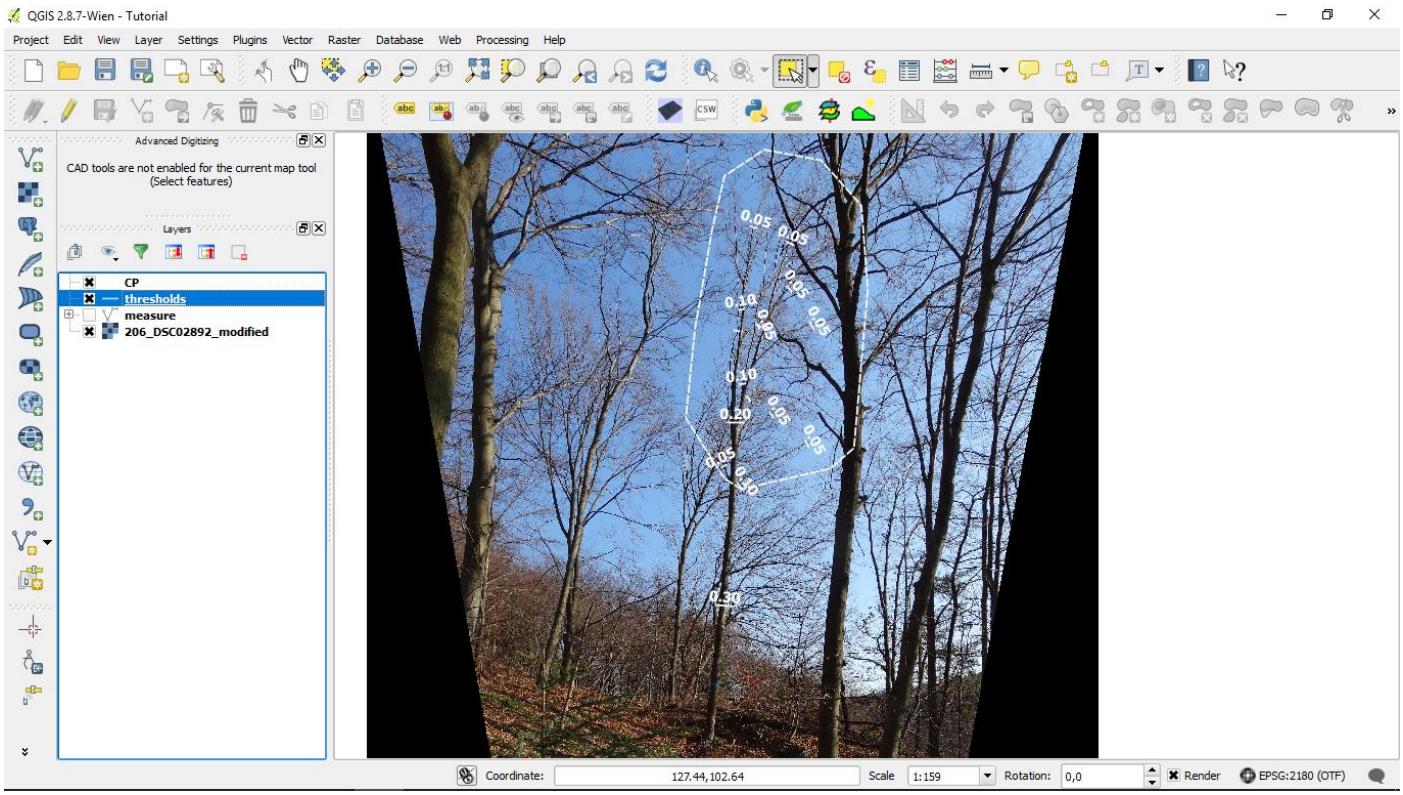



III Drawing the axes of trunk and branches and applying thickness attribute

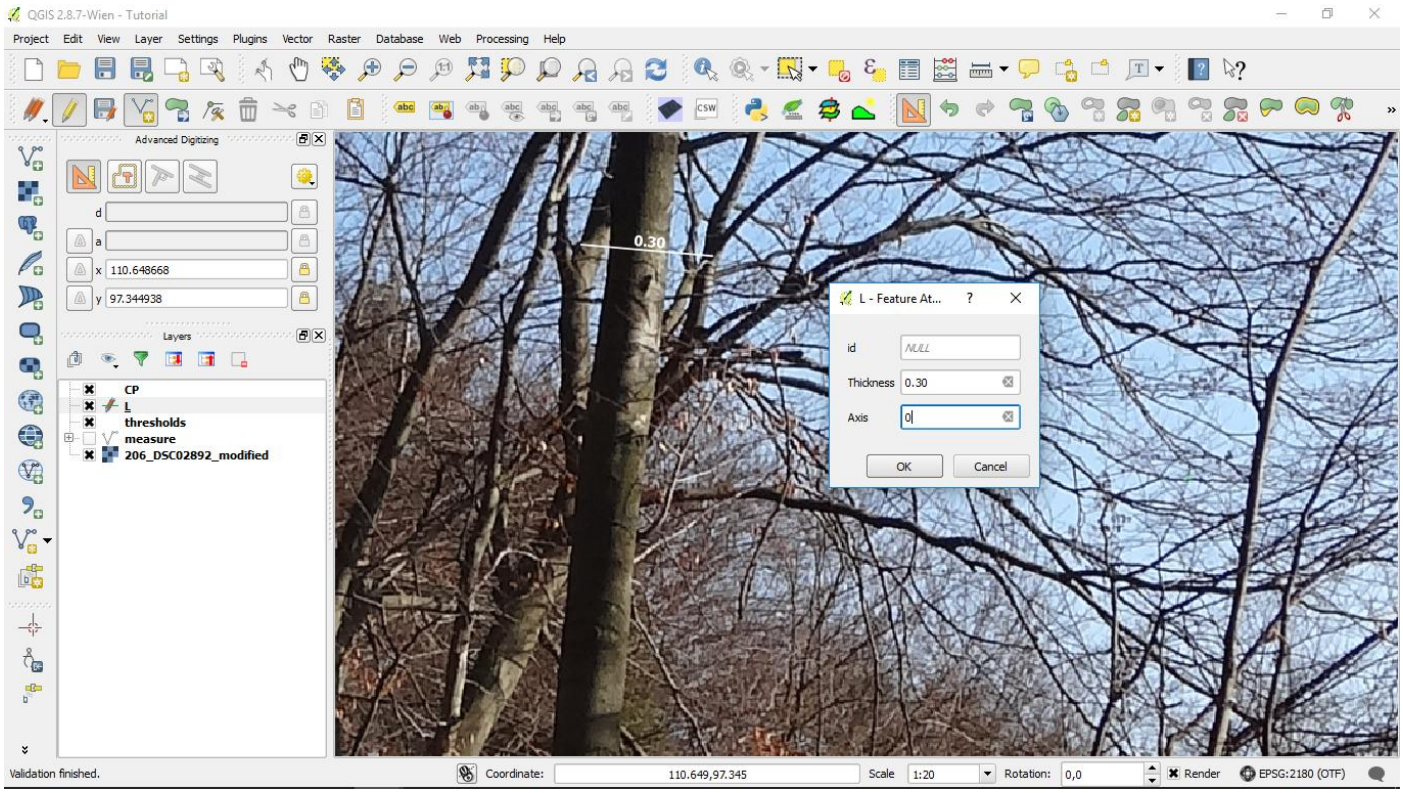
Finally, we show how to measure the length of trunk and branches (L) – in respect to both branch thickness and axis order.

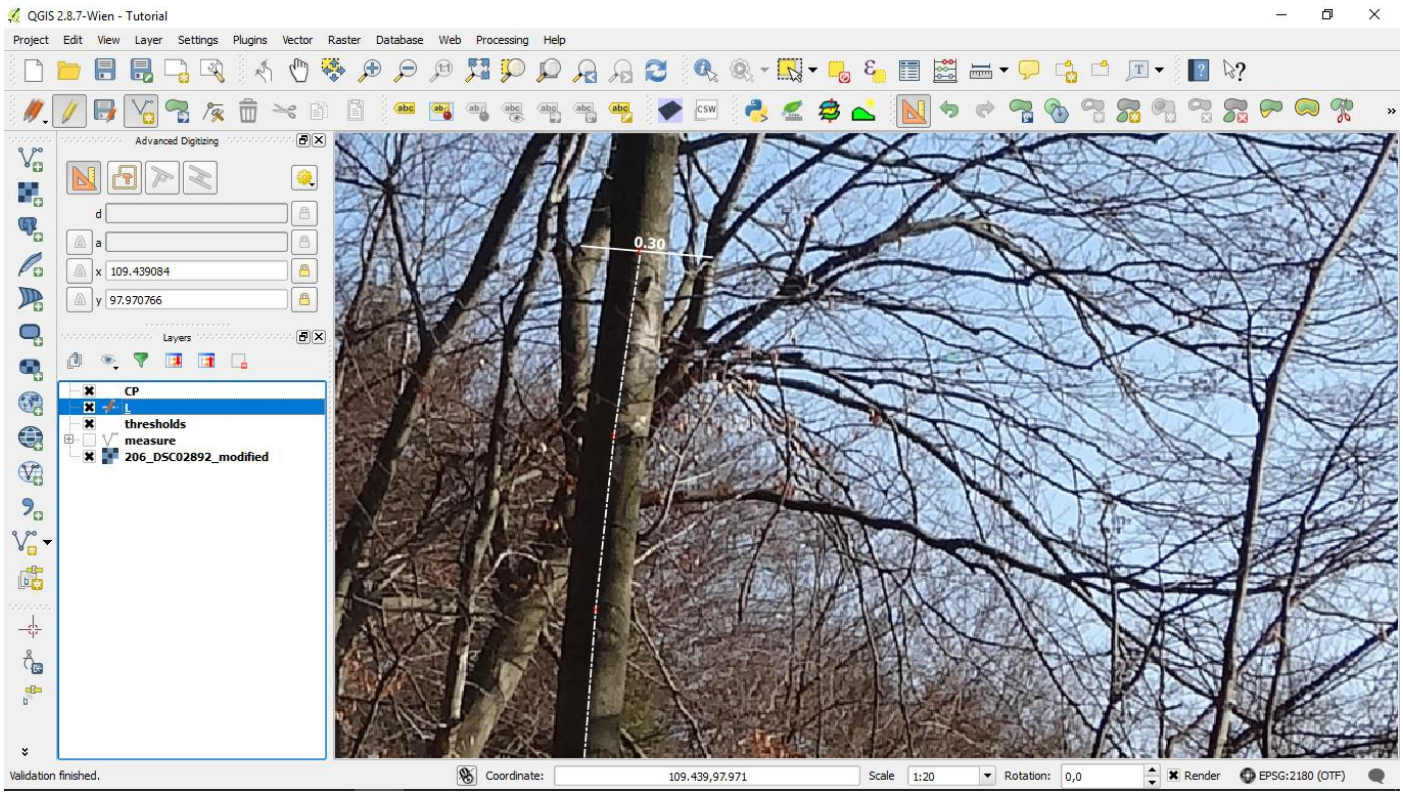
1. Create a new vector layer ‘thresholds’ (Type – Line). This layer will contain thresholds for trunk and branches thickness: 0.30, 0.20, 0.10, and 0.05 (m). To quickly find the thresholds, you may use the ‘Measure line’ tool, as shown below. It is helpful to know the pixel size (here it is 0.7 x 0.7 cm), which can be found with: Raster > Miscellaneous > Information...



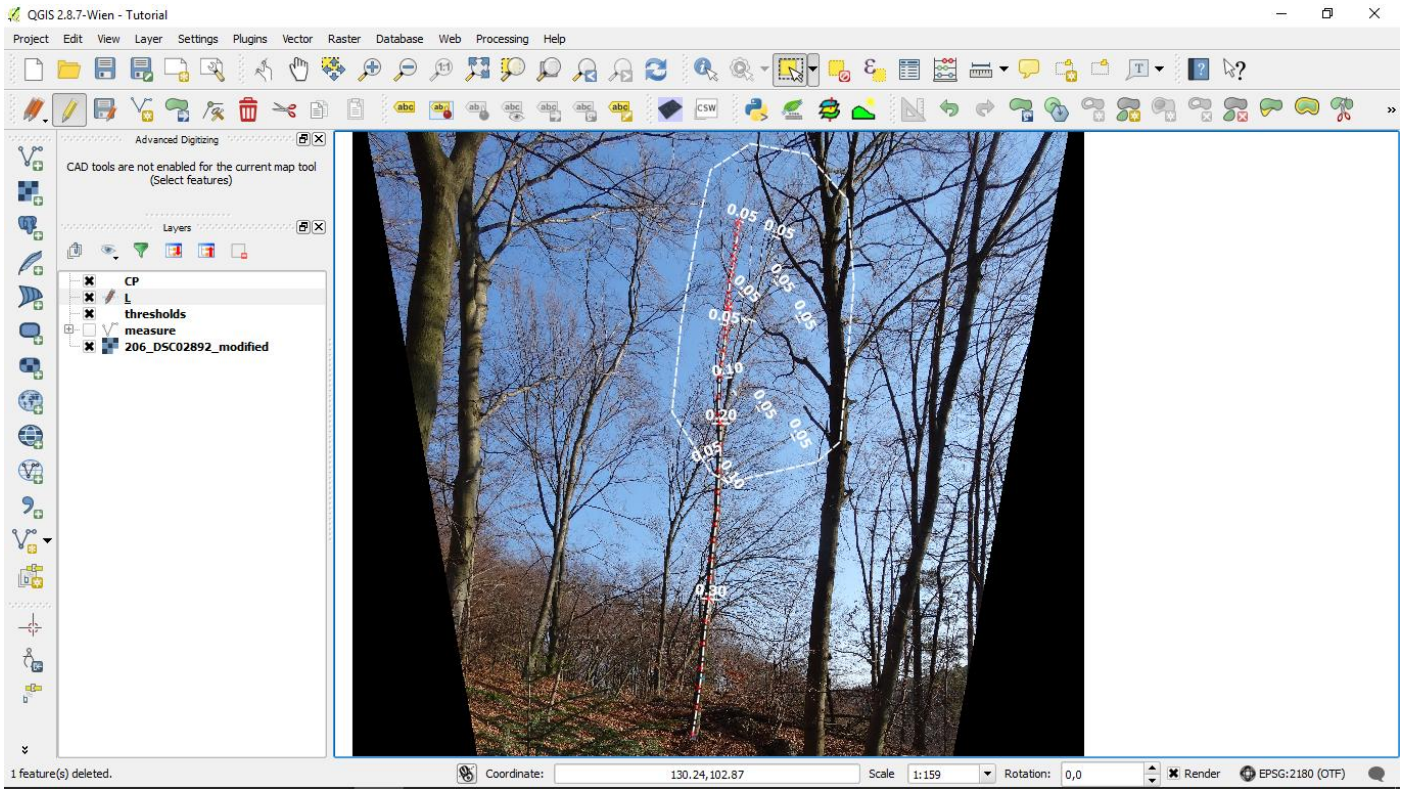




2. We will use four classes of thickness: >0.30 m (I), 0.30-0.20 m (II), 0.20-0.10 m (III), and 0.10-0.05 m (IV). Branches thinner that 0.05 m will not undergo digitization. Create another vector layer ‘L’ (Type – Line), and add two attributes: Thickness (decimal numbers) and Axis (whole number). Start digitizing the axes, going upward from the base of the tree. Finish each line after reaching a threshold and type in the Thickness and Axis (order) in the new window:

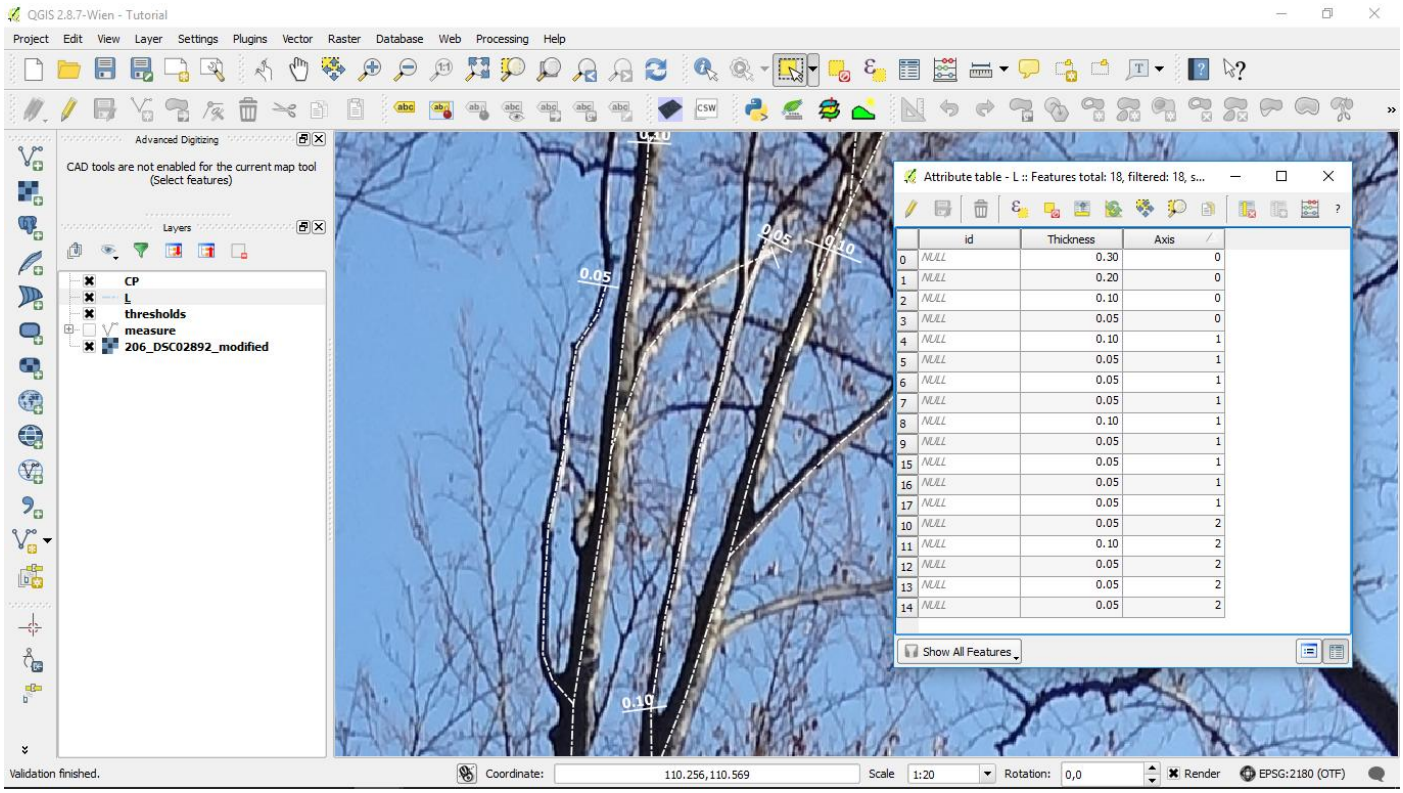


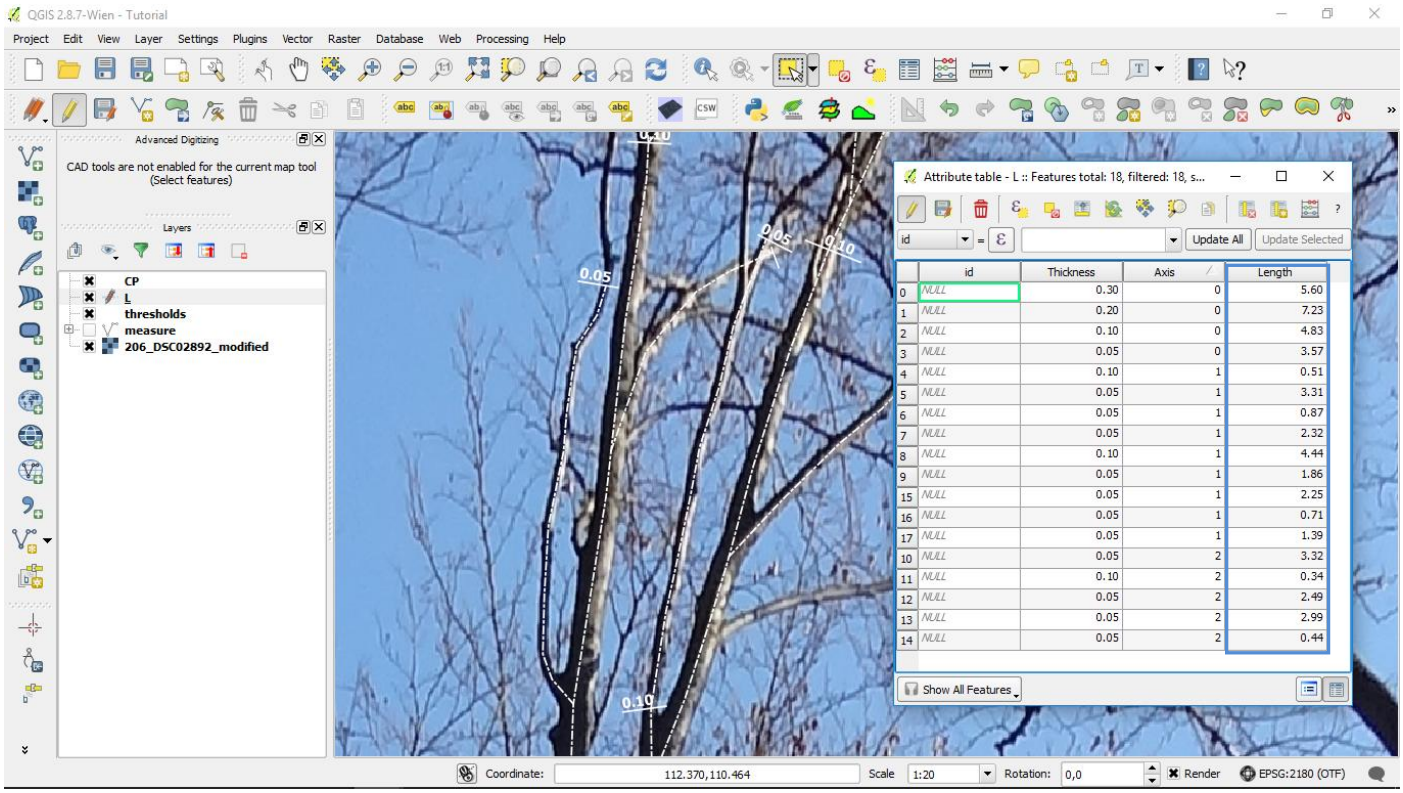

Note: while digitizing the axes, it is useful to turn off snapping to common angles (‘do not snap to common angles’ in Advanced Digitizing window settings). When the axis order analysis is included, it is best to start with the ‘0’ axis:

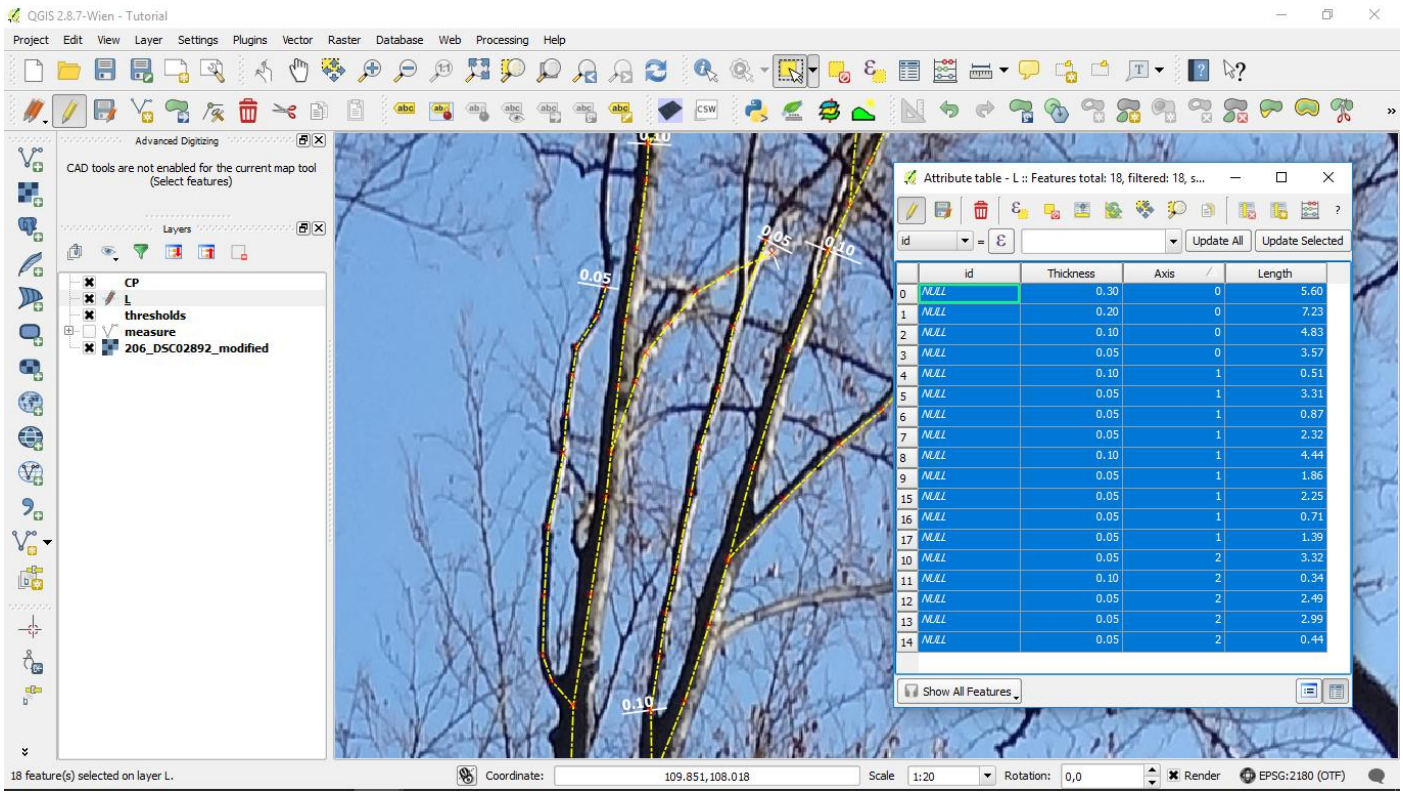



3. The digitizing is finished when all thresholds are reached:




4. Open the Field calculator, and Create a new field (‘Length’), use the function ‘$length’:




Note: the data (including geometry) may be easily exported with ‘Copy selected rows to clipboard’ (Ctrl+C).

The measured lengths in classes of thickness are as follows: I – 5.60 m, II – 7.24 m, III – 10.12 m, IV – 25.52 m (48.47 m total, for classes I – IV); and in respect to axis order: 0 order – 21.23 m, 1$^{st}$ order – 17.66 m, 2$^{nd}$ order – 9.58 m.

5. To create a realistically looking tree silhouette, you may assign different line widths to the classes of thickness: highlight the ‘L’ layer, go to: Layer > Properties > Style, and choose ‘Categorized’ by the Column ‘Thickness’; click ‘Classify’, and specify the line type, width and colour for each value (0.05-0.30).