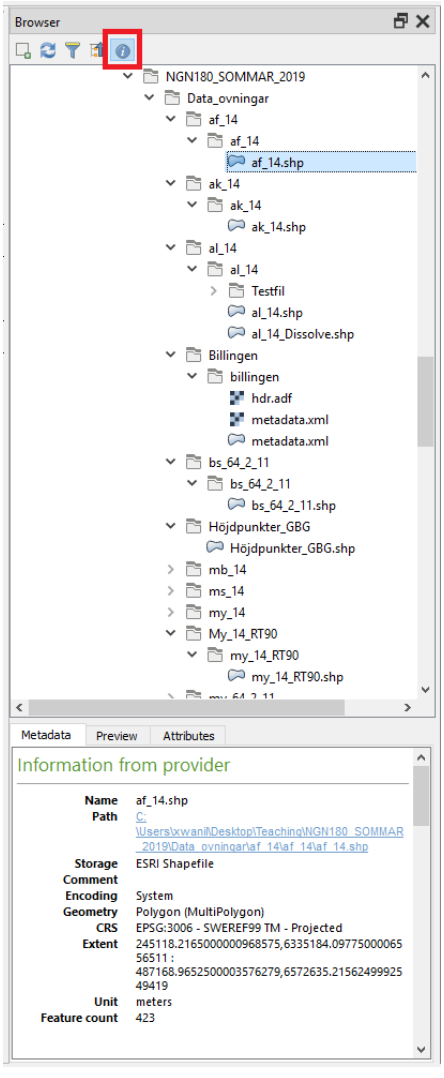
# Exercise 4 – Assign a coordinate system, create new files and digitalize

**Documentation on projections:** https://docs.qgis.org/3.10/en/docs/user_manual/working_with_projections/working_with_projections.html
**Documentation on editing:** https://docs.qgis.org/3.10/en/docs/user_manual/working_with_vector/editing_geometry_attributes.html#editing

In exercise 4 we look closer on how to define and change projections as well as create new layers in QGIS. First you will learn how to assign a coordinate system to your data. There are a large number of coordinate systems adapted to different areas of usage. In Sweden the two most used coordinate systems are RT90 and SWEREF99. You will also learn how to change coordinate system on your data. RT90 is an old coordinate system used in Sweden before the new and updated SWEREF99. Even though it is outdated it is still fairly common and you will probably encounter it at least once. In the second part of this exercise you will learn to create and edit polygons. Lastly you will learn how to extract the geographic information contained in the layers, for example coordinates, areas and distances.

**Assignment:** Hand in a print screen of the attribute table showing your area calculation in km² for your created polygon(s). Like the example on the next to last page showing the x- and y-coordinates for the points. Paste the image into a word-document and send in a **PDF-copy** on GUL.

## 1. Getting started

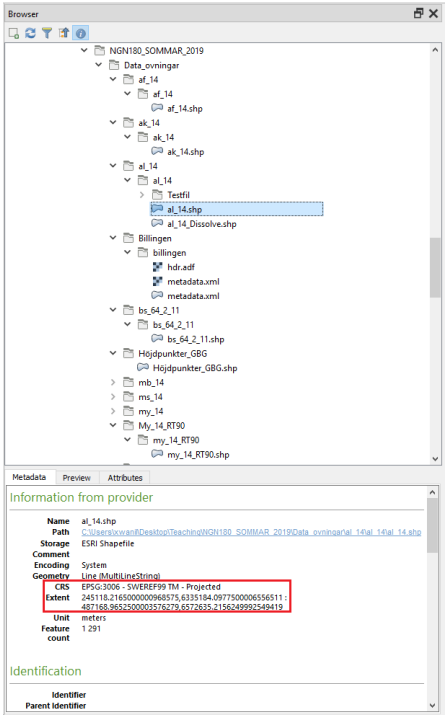



As usual, open QGIS Desktop and create a folder to save your project files in. Look in the browser (probably to the left of your QGIS window). The browser is like a file manager. Here you can browse files and their metadata (information about the data) and attribute information, for example (as you can see in the bottom panel). If the metadata panel is not visible just press the button in the red box.

## 2. Choose a coordinate reference system

You need to assign a reference system to all the layers included in your project. To be able to perform analyses and visualize the layers there needs to be a coordinate reference system in place. In QGIS the reference system can be changed through Coordinate Reference System (CRS). There are two different types of coordinate systems, Geographical coordinate systems and Projected coordinate systems. Geographical coordinate systems use latitude and longitude to specify places on the different earth ellipsoids used. Projected coordinate systems project the ellipsoid (Earth) on a flat surface in various ways, and use different distance units (meter, feet etc.) to describe distances. A projected coordinate system is always based on a geographical one.

Use the browser and find the folder where you keep all the layers used in the course. Choose one of the shape files, for example **al_14.shp**, by highlighting it. Metadata for the chosen layer will now be visible in the bottom window. Under **CRS** there is information about the reference system.



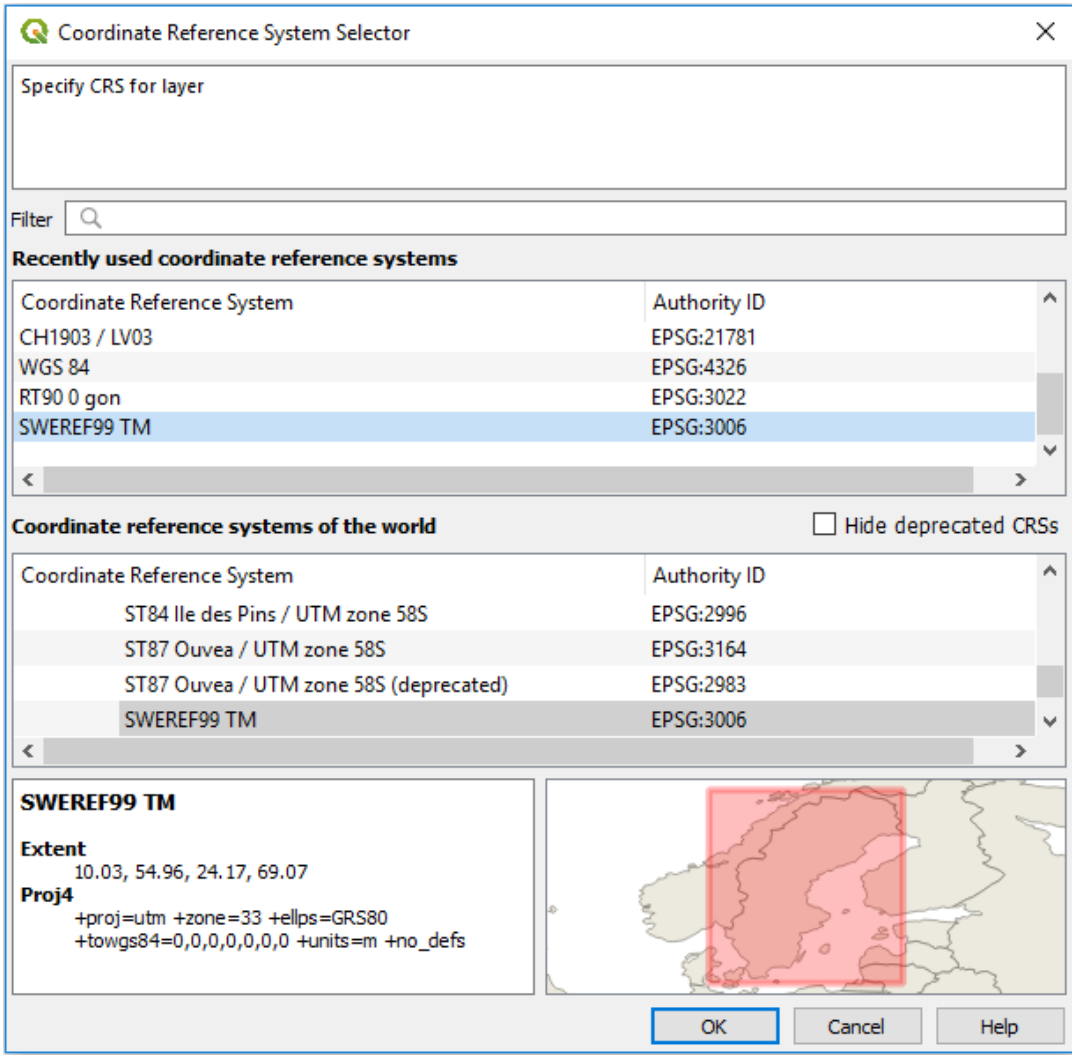

SWEREF99 TM is of the type Transversal Mercator (TM) projection and a GRS80 ellipsoid. The unit of length used is meters. You must make sure that all of the data has the same reference system.

In the case you must create your own reference system or assign a coordinate system to your layers there are different ways to do this.

If a layer does not have a predefined reference system it can have one assigned when you add the layer to the project. A prerequisite is that you know which reference system the layer is based on. If a layer does not have a predefined reference system a window like the one in the figure below will pop up. Choose a reference system by browsing the list or searching, selecting the one you want to use and pressing OK. In this course all of the data will be in SWEREF99 TM (with the exception of my_14_RT90.shp). If you get a message like this:

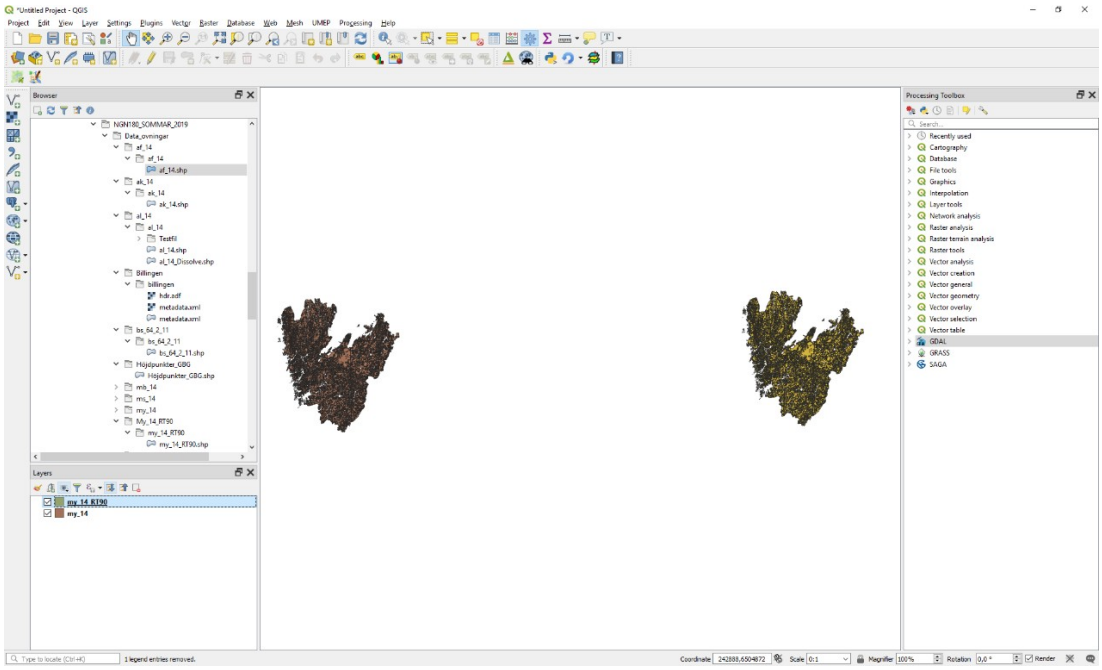

when looking at the metadata or trying to add the layer to the project you need to set the Selected CRS to SWEREF99 TM. Be aware that if the layer already has an assigned reference system (e.g. RT90) you need to **transform** it to the requested system, you can not simply change it. We will go through transformations between different reference systems later in the exercise. When you made sure all the layers (except for my_14_RT90) have the right coordinate system you can continue.

If you got the message above, add the layer to the project and you will be prompted with the message in the figure below. When this happens assign the requested coordinate system, which still is SWEREF99 TM.



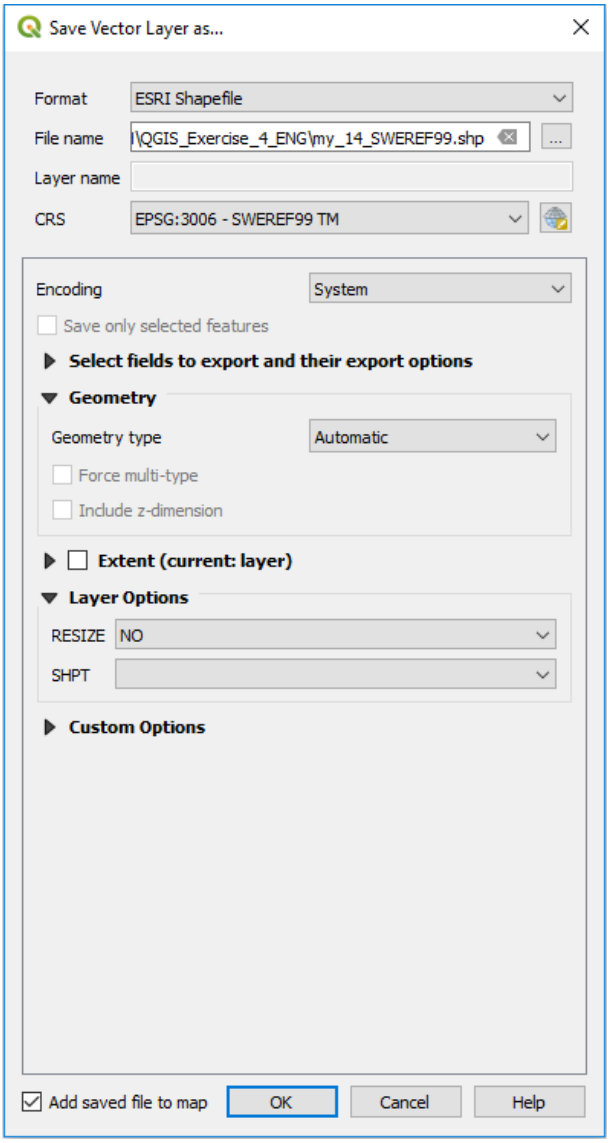
## 3. Change of coordinate system

During the transition between RT90 and SWEREF99 in Sweden data had to be reprojected to the new coordinate system, i.e. from RT90 to SWEREF99. We are going to perform the same transformation. In QGIS you can do so called on the fly transformations which means that a layer temporarily is transformed to the same reference system as the rest of the projects layers. This is not a good solution if the layer should be used for analyses of different kinds. Therefore we will remove the automatic on the fly reprojection. Open **Project → Properties → CRS** and choose "**No Projection"**. Click OK. In this part of the exercise you should add the layers **my_14.shp** and **my_14_RT90.shp** in QGIS Desktop. Double check if my_14.shp has SWEREF99 TM as defined coordinate system. Press **Zoom full** The layers will probably not be in the same "place", but they *could* be overlapping (if so, go to **Options** again and check '**No projection**' again). They are regardless not compatible with each other and the coordinate system of my_14_RT90 thereby needs to be changed.



To transform the coordinates right-click ***my_14_RT90*** and click **Export > Save features as…**. A new window appears where you can choose reference system for the new layer you are creating. Leave ESRI Shapefile (**SHP**) as Format and name the new file **my_14_SWEREF99** (See image below). Choose SWEREF99 TM as CRS through the Coordinate Reference System Selector and click OK.

Add the new layer and make sure that it is positioned on top of my_14.shp. By saving the layer with a new reference system it has been reprogrammed to fit into the new system. **IF** the my_14 and the transformed my_14_SWEREF are not positioned on top of each other, remove all layers and add them again, then it should work.




Be advised that other GIS softwares and systems have other methods for reprojecting data. It is usually performed by a specific tool and not by saving a new layer. Make sure to find out how the process works when you start working with a new software.

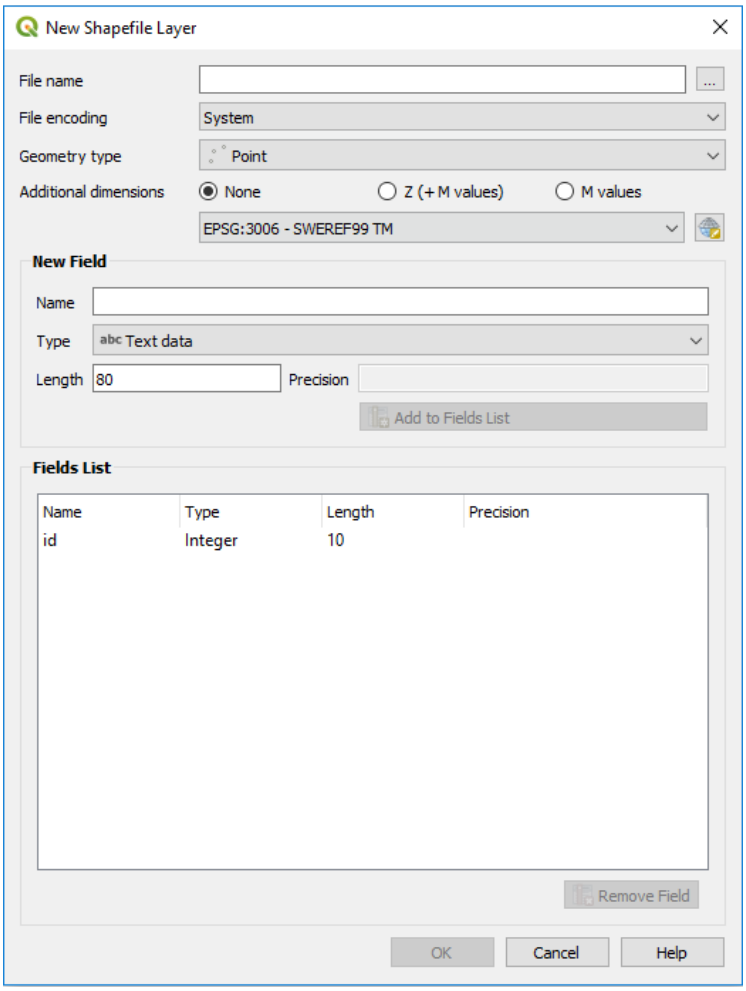
## 4. Create new Shapefiles

a) Create a copy of a layer in QGIS

There are several ways to create new shapefiles. The easiest way is to copy an already existing file. It is a good idea when you want to edit your data and still save an untouched version of it. To copy a layer in QGIS you simply right-click it and choose **Duplicate Layer**. The copy will then appear in the Layers window. Make a copy of one of the layers, and hide or remove the other layers from the layer window.

b) Create a new shapefile

New shapefiles are created by clicking the symbol **New Shapefile Layer**  located in the icon panel. You could also go to ***Layer > Create layer > New Shapefile layer…***




A new window appears where you decide what type of vector layer to create. The choices are Point, Line or Polygon. Create one point, one line and one polygon layer. You have to do it separately. Make sure the coordinate system is SWEREF99, it is easily changed under **Select CRS**. Click OK and choose where to store them and give them an appropriate name.

## 5. Create new points, lines and polygons in the new layers

To create new points, lines or polygons the **Digitizing** toolbar needs to be enabled. It looks like this: 

If it is not on the menu toolbar simply right-click anywhere on the menu and check the box for Digitizing toolbar and it should appear. Right-click your empty point layer and click **Toggle Editing**. A symbol of a pen should now be visible on the point layer in the layer window and it means that the layer can now be edited. Then click the **Add Feature** symbol in the digitizing toolbar. You can now click in the map to create a new point. Create a some of points (5-10). You will also be asked to give each point an id. When you have created your points click **Toggle Editing** again and a window appears where you choose to save the changes. You can also save during editing by clicking **Save Layer Edits.** Remember to save the points layer, since you will need it during the next exercise!

Choose **Toggle Editing** for the line layer as well and click where on the map you want the new line to start. Left-click to create a break in the line and when the line is finished simply right- click. Create a couple of lines and do not forget to save. Polygons are created in a similar way. Create a couple of polygons as well.

## 6. Edit objects (see also: https://docs.qgis.org/3.10/en/docs/user_manual/working_with_vector/editing_geometry_attributes.html#advanced-digitizing)

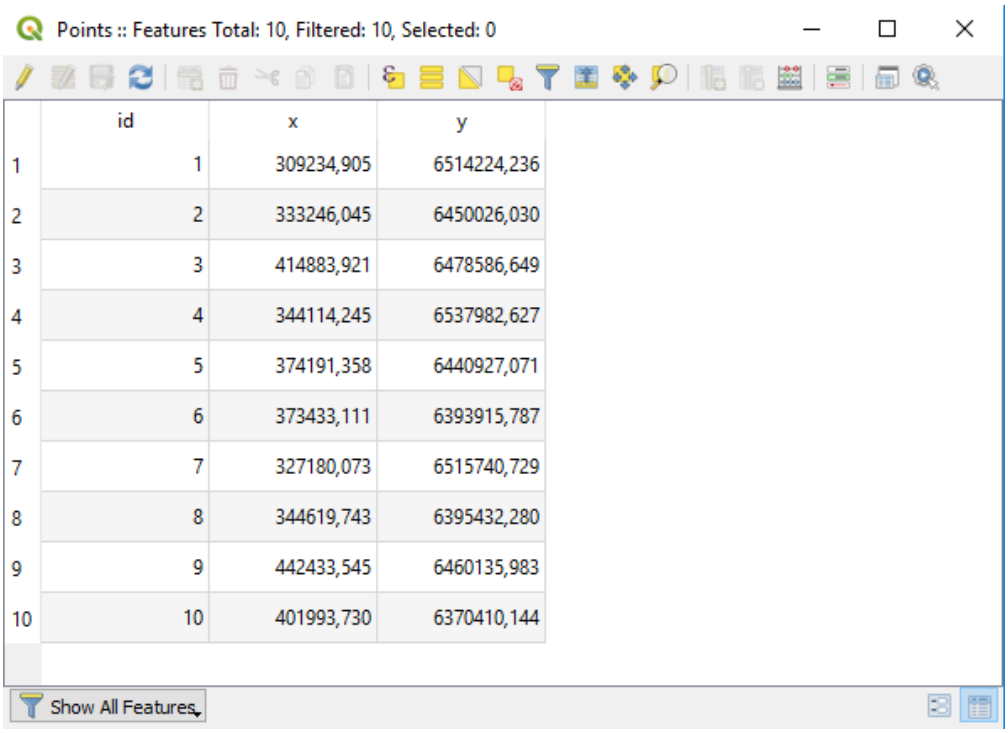
If you are dissatisfied with your points, lines or polygons it is easily fixed. There are several editing tools in the **Digitizing** toolbar. By using the **Vertex Tool** you can move and remove points or vertices in lines and polygons. Just left-click on the node or point you want to move and drag it by holding in the mouse button. To remove a vertex or point click on it so a blue square appears then press delete on your keyboard (for Windows). You can also create new vertices by selecting a feature and double-clicking somewhere on its border.

There are even more advanced editing functions. You can enable those by View > Toolbars > Advanced Digitizing Toolbar. For example, in order to move a whole feature while keeping it intact use the tool **Move Feature(s)**. To remove a point, line or polygon you need to highlight it either in the attribute table or by using the tool **Select Features by area or single click**. Then click **Delete Selected**.

## 7. Viewing X- and Y-coordinates for points

You can find out the coordinates of a point in three different ways. The easiest way is to hoover with the mouse pointer over the point to see approximate coordinates. The coordinates will then be visible in the small ***Coordinate*** window below the map. In case your layer has attributes with the coordinates you could also use the **Identify tool** (  ) and click on a selected point (the point layer must be active) to check information about the point, including coordinates.

Another alternative is to open the attribute table for the point layer, enable **Toggle editing mode** and press **Open field calculator**. Name the new field x and choose **Decimal number (real)** under output field type. Under functions drop down the plus next to **Geometry** and double-click **$x**. Click OK and the x-coordinates will calculated and shown in the new column you just created. See that it looks ok and then do the same procedure for the y-coordinates (but use **$y**).




| | id | x | y |
|---|---|---|---|
| 1 | 1 | 309234,905 | 6514224,236 |
| 2 | 2 | 333246,045 | 6450026,030 |
| 3 | 3 | 414883,921 | 6478586,649 |
| 4 | 4 | 344114,245 | 6537982,627 |
| 5 | 5 | 374191,358 | 6440927,071 |
| 6 | 6 | 373433,111 | 6393915,787 |
| 7 | 7 | 327180,073 | 6515740,729 |
| 8 | 8 | 344619,743 | 6395432,280 |
| 9 | 9 | 442433,545 | 6460135,983 |
| 10 | 10 | 401993,730 | 6370410,144 |

Do the same procedure for the line layer but use **$length** under **Geometry** instead. Since the project is in SWEREF99 which uses meters as length unit you will by this procedure find out how long in meters your lines are. To convert meters to kilometers you simply divide by 1000. The expression in the field calculator then becomes: **$length / 1000.**

To calculate the area of a polygon you do the same procedure for the line layer, with the difference being that you use **$area** instead of **$length** under **Geometry**. Once again you get the result in meter unit i.e. square meters. To convert square meters to, for example, square kilometers divide it by 1000000. The expression is then: **$area** / 1000000.

End of Exercise 4!

**Assignment:** Hand in a print screen of the **attribute table showing your area calculation in km² for your created polygon(s)**. Similar to the example on above showing the x- and y-coordinates for the points. Paste the image into a word-document and send in a PDF- copy on GUL.