Introduction to GIS using QGIS

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Session Info

You can download the data here at: github.com/andreatitolo/qgis_training_data/raw/main/training_data.zip

We will use data on the location of **roman forts, settlements and roads** in Britain (freely available from the Ancient World Mapping Center website and **national boundaries** of UK and Ireland (freely available at NaturalEarthData website).

Today's session:

- Introduction to GIS/QGIS
- Spatial Data Types (Vectors/Raster)
- Open QGIS and familiarize with the interface
- Load vector data
- Inspect and change layer style
- Load CSV data

In the meantime, open QGIS!

If for any reason you are not able to follow along, you can download this presentation in pdf which has all steps of this session illustrated at:
github.com/andreatitolo/qgis_training_data/raw/main/AT_Introduction_to_qgis.pdf

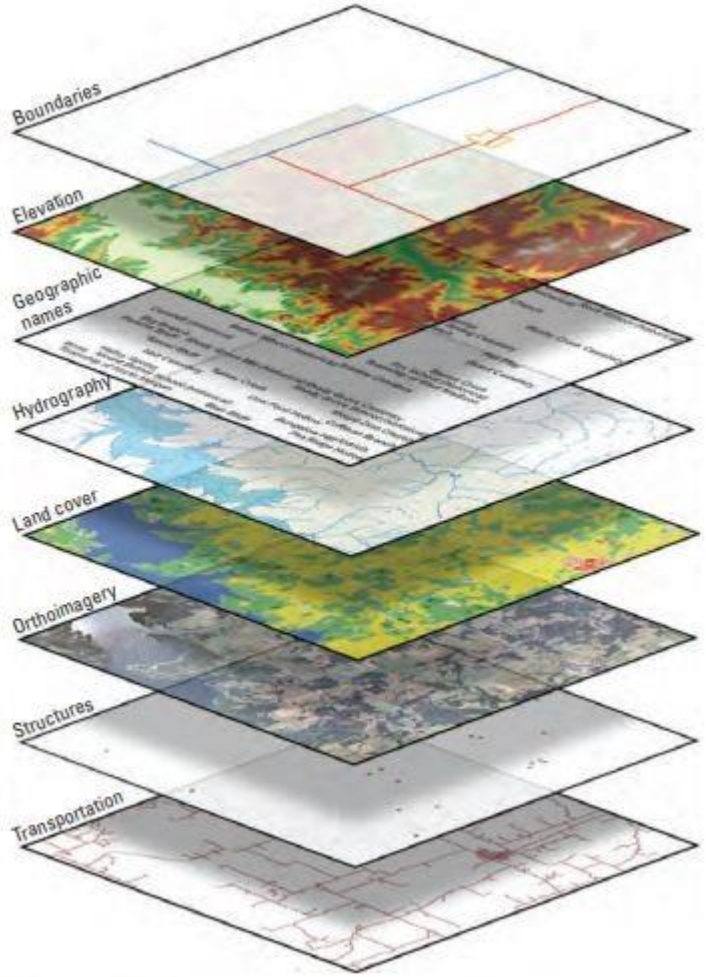
Or scan the QR code on the right with your phone! →

What is a GIS?

What is a GIS?

GIS stands for either **Geographic Information System**

Software/programs that we use to store, manipulate, analyse, manage, and present all types of geographical data and to analyse relationships between those data.



What can GIS do for Archaeology?

A large variety of applications:

- Mapping
- Site Detection
- Archaeological Survey – Field recording
- Archaeological Excavation
- Cultural Heritage Recording and Monitoring
- More complex tasks (e.g. Spatial Analysis)
- 3D
- WebGIS

PyArchinit plugin for QGIS, main interface with stratigraphical units displayed.

The archaeological site of Mari (Tell Hariri) in Syria, as seen from Google Earth satellite image.


QGIS

What is QGIS?

www.qgis.org

From the QGIS website, "QGIS is a user friendly Open Source Geographic Information System (GIS) licensed under the GNU General Public License. QGIS is an official project of the Open Source Geospatial Foundation (OSGeo). It runs on Linux, Unix, Mac OSX, Windows and Android and supports numerous vector, raster, and database formats and functionalities."

QGIS is a desktop GIS. You have a Graphical User Interface (or GUI) that you can work with, with buttons, windows or forms you can fill in order to do things.

QGIS is open source. The code is available to the users to read or modify. What's the advantage of this? It means anyone can make fixes if something is wrong or anyone can add new features. It is generally faster for open-source programs to fix bugs and implement new things.

Why QGIS?

QGIS is an community-driven, open-source desktop GIS software that allows users to visualize and analyse **spatial data** in a lot of different ways.

Some advantages of QGIS are:

- It's a robust, powerful desktop GIS.
- Runs on all major OS: MacOS, Linux, & Windows.
- Free of charge, no need to worry about licences.
- Frequent updates & bug fixes.
- Accessible, comes in more than 50 languages (depending on the version), making it easier to work with a large variety of collaborators.

Spatial Data Types

Spatial Data = Any data related to or containing information about a physical object that has a size, shape and specific location on the Earth's surface, and is represented in a geographic coordinate system.

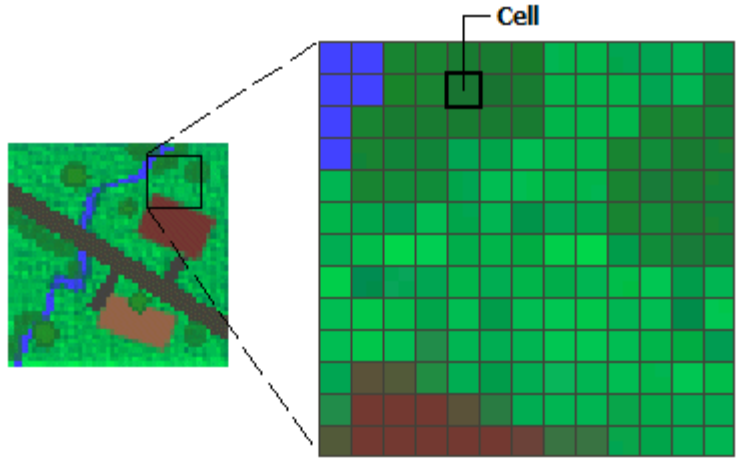
Vector

Points

Lines

Polygons

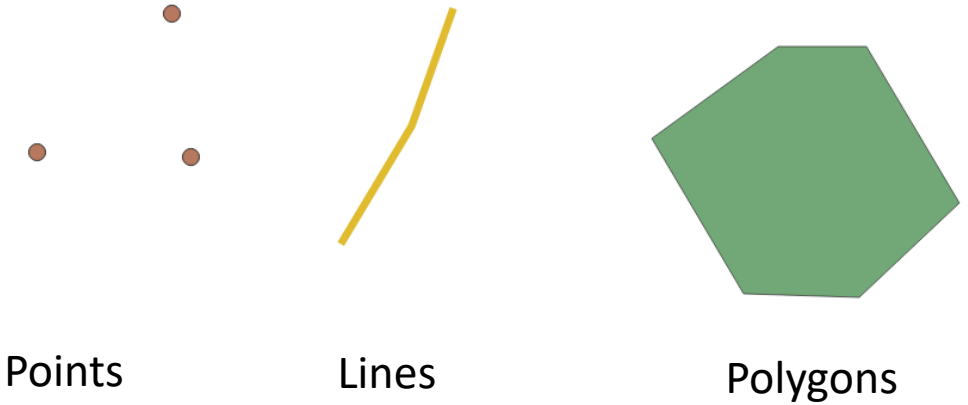
Raster



Spatial Data Types

Spatial Data = Any data containing information about a physical object that has a size, shape and a **specific location** on the Earth's surface. This location is recorded with geographical coordinates.

Vector

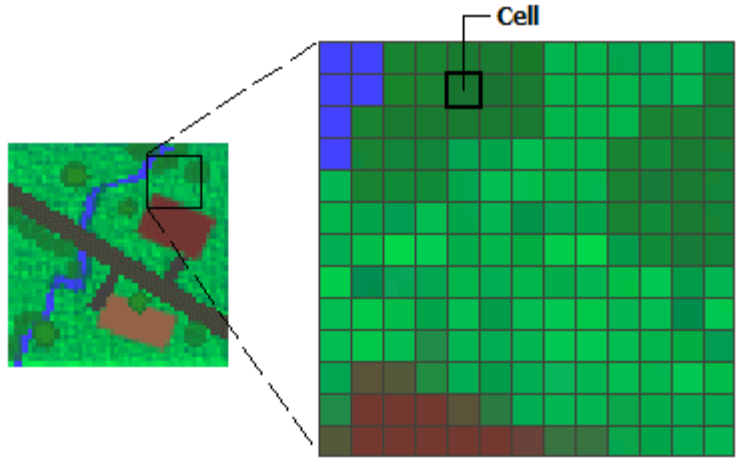


Points

Lines

Polygons

Raster



Vectors

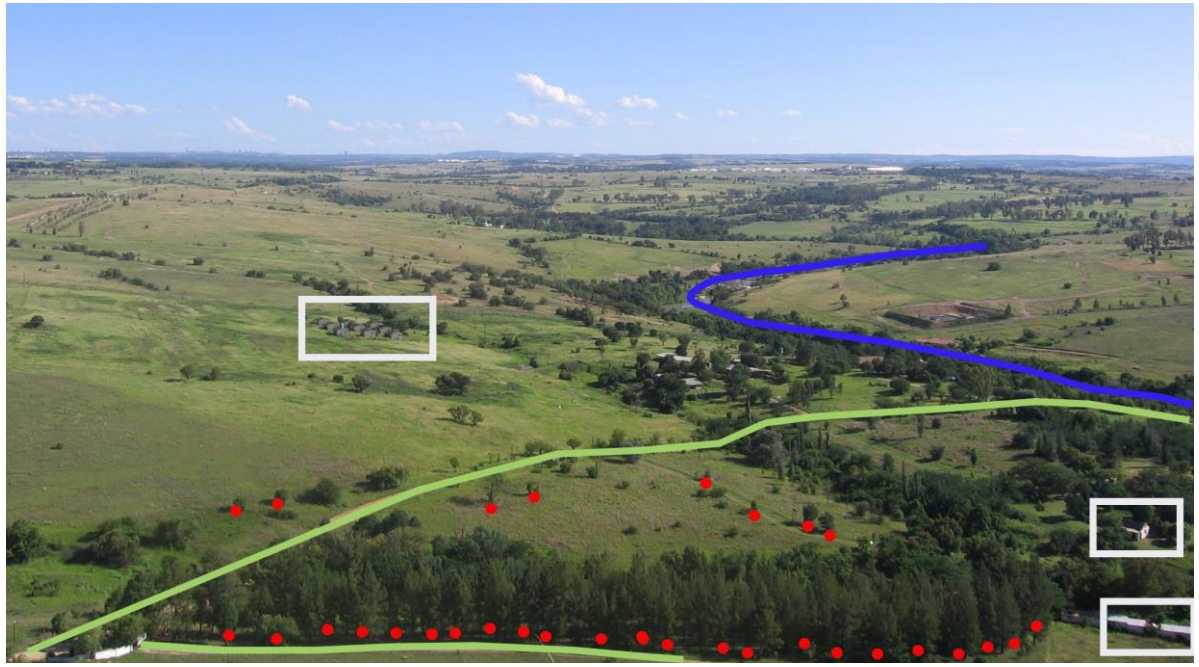
- A representation of the real world using three geometries: **points, lines and polygons .**
- They have **attributes**, which consist of text or numerical information that **describe** the features.
- Better at representing **discrete** data (i.e. data present in specific locations, e.g. Rivers, Buildings, Roads, Trees).
- Stored in different file formats, most common are the **shapefile** (.shp) and **comma separated value** (.csv).

In archaeology

Points -> Find Spots, Archaeological Sites on a regional map

Lines -> Linear Features (e.g. paleochannels)

Polygons -> Stratigraphical Units, Structures, Site extent



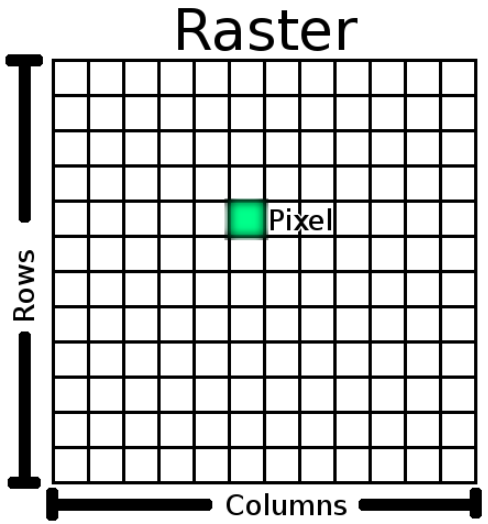
Real world landscape and its features as we would represent them in GIS using vector geometries (source: QGIS Documentation).

Rasters

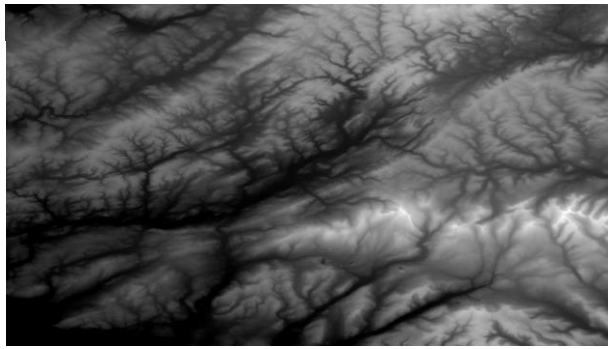
- **Gridded data**: made up of an underlying grid of cells (**pixels**), each of which is attributed a **numeric value**.
- Each cell contains information about what should go into that cell.
- Better at representing **continuous** data
- Stored in different file formats, most common for GIS is GeoTIF (.tif)

In archaeology

Raster data can be:
elevation data, rainfall/temperature data, satellite images, aerial/drone photos

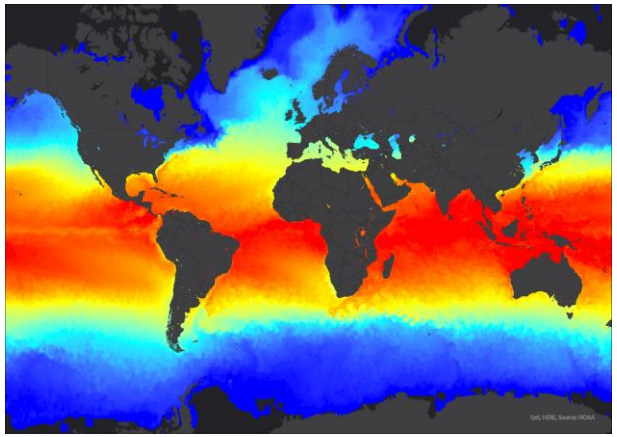


Raster data structure (source: QGIS documentation)

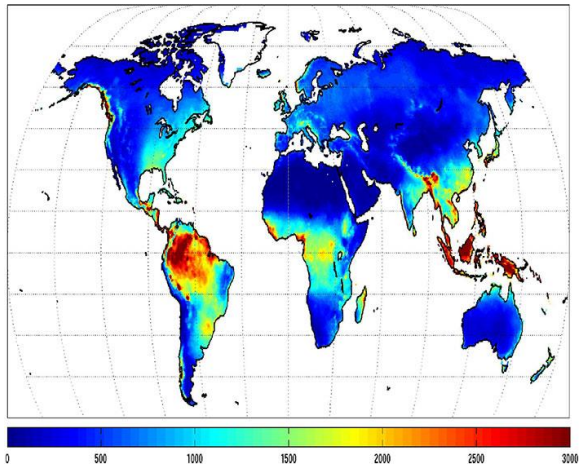


Elevation raster image (DEM) of the area north of Swansea, Wales (@USGS)

Archaeological site of Haradum in Iraq, as seen on a Bing Maps satellite image (@BING).



Sea temperature raster data (source: @Esri/NOAA)



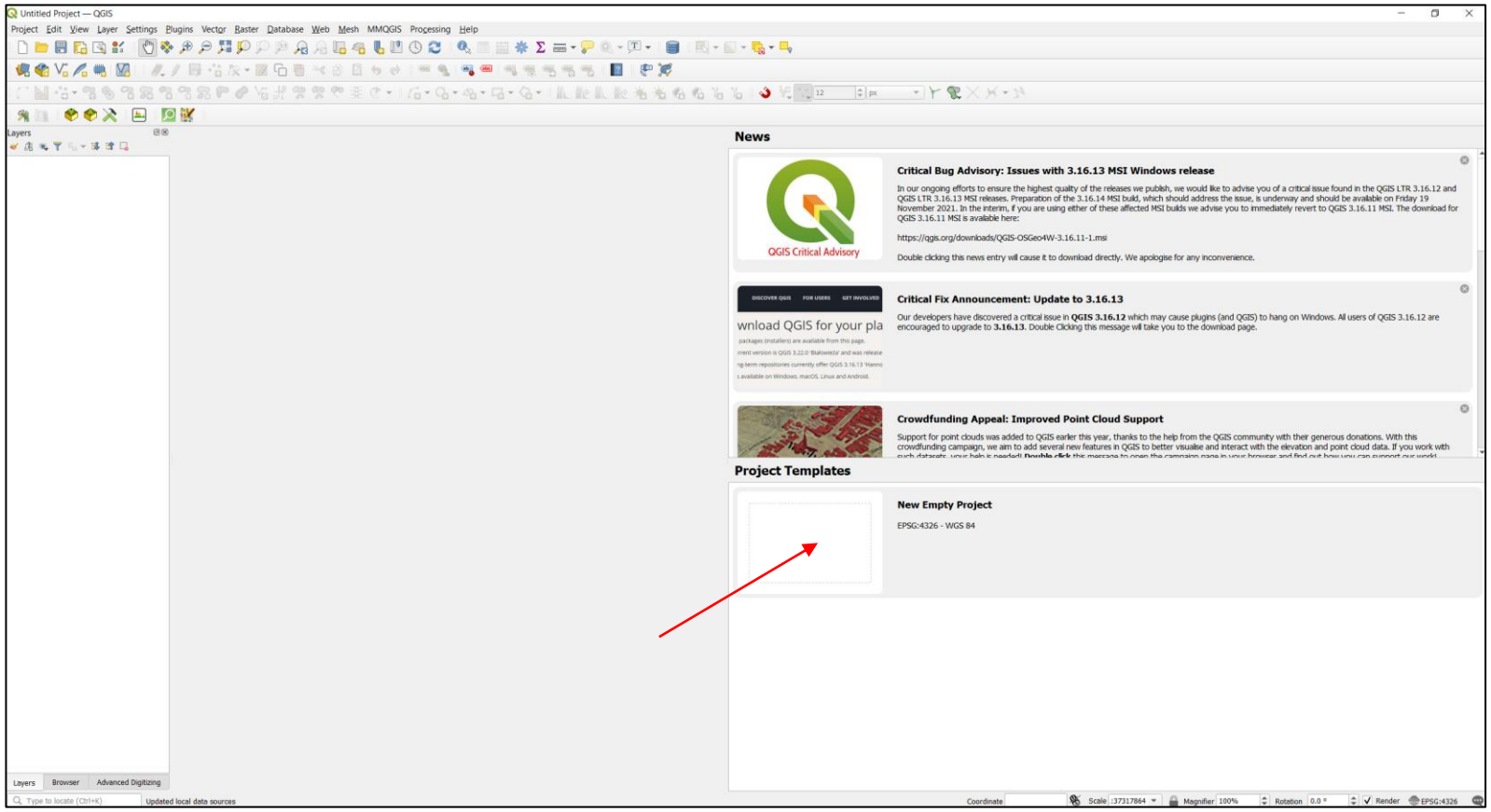
Global average annual rainfall data (source: @NASA)

Let's open QGIS!

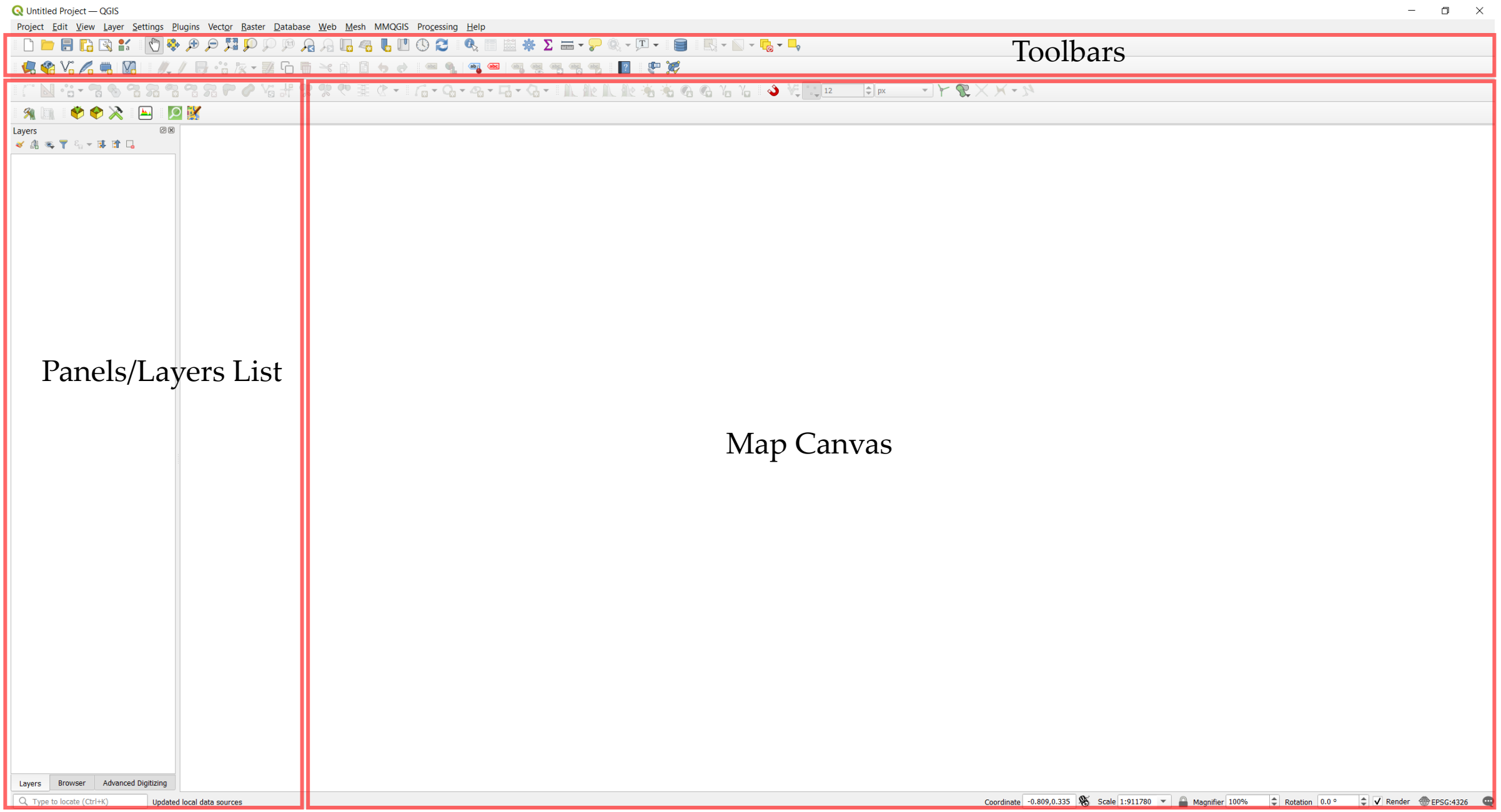
- (Windows) Click on the Desktop icon
- (Mac) Launch the application

- Or launch the program from the executable (usually found under **C:\OSGeo4W\bin\qgis-ltr-bin.exe** or **C:\Program Files\QGIS-3.16\bin\qgis-ltr-bin.exe**)

- Double-click on **New Empty Project**

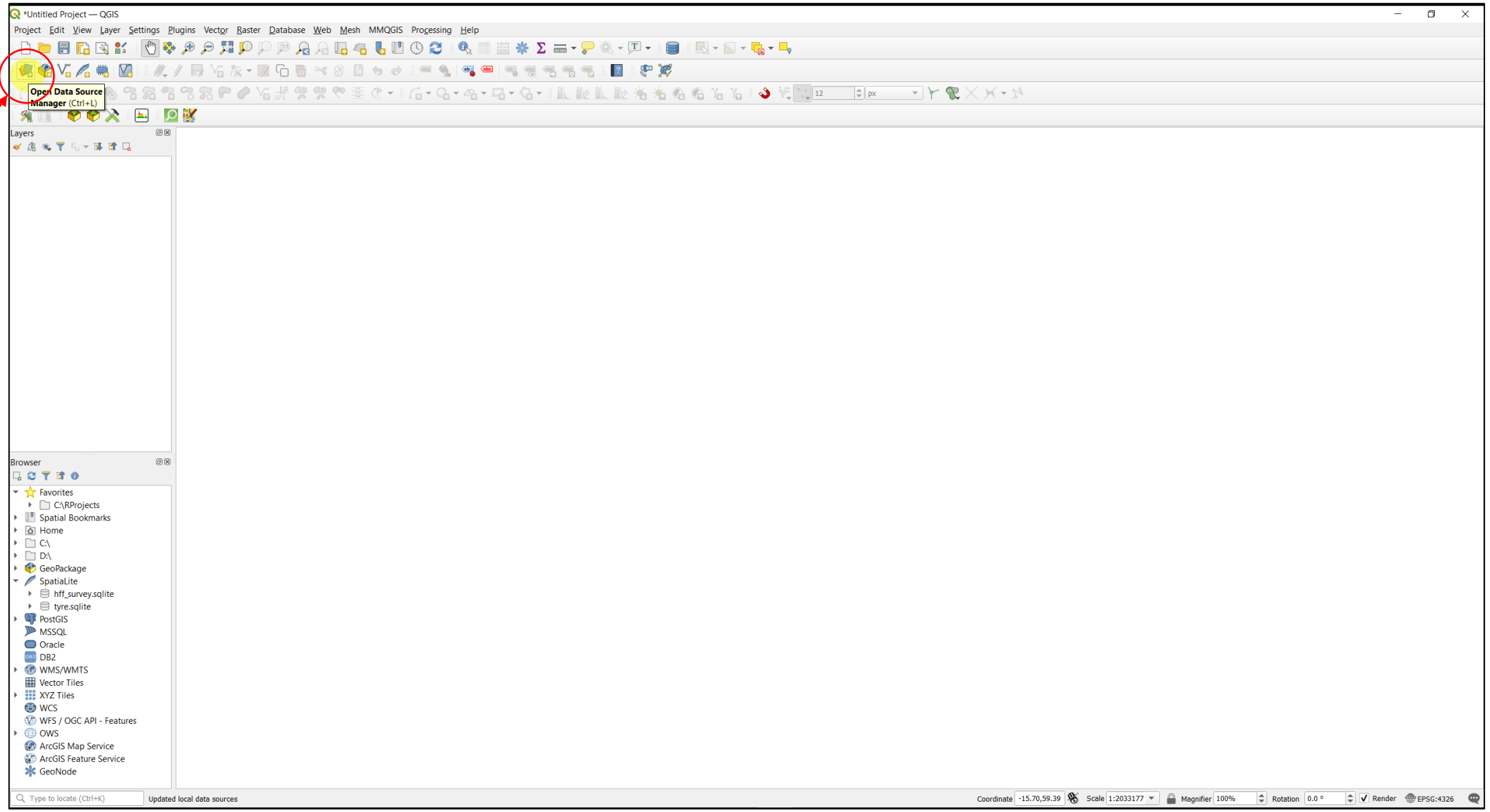


QGIS Interface



Load Data - Vectors

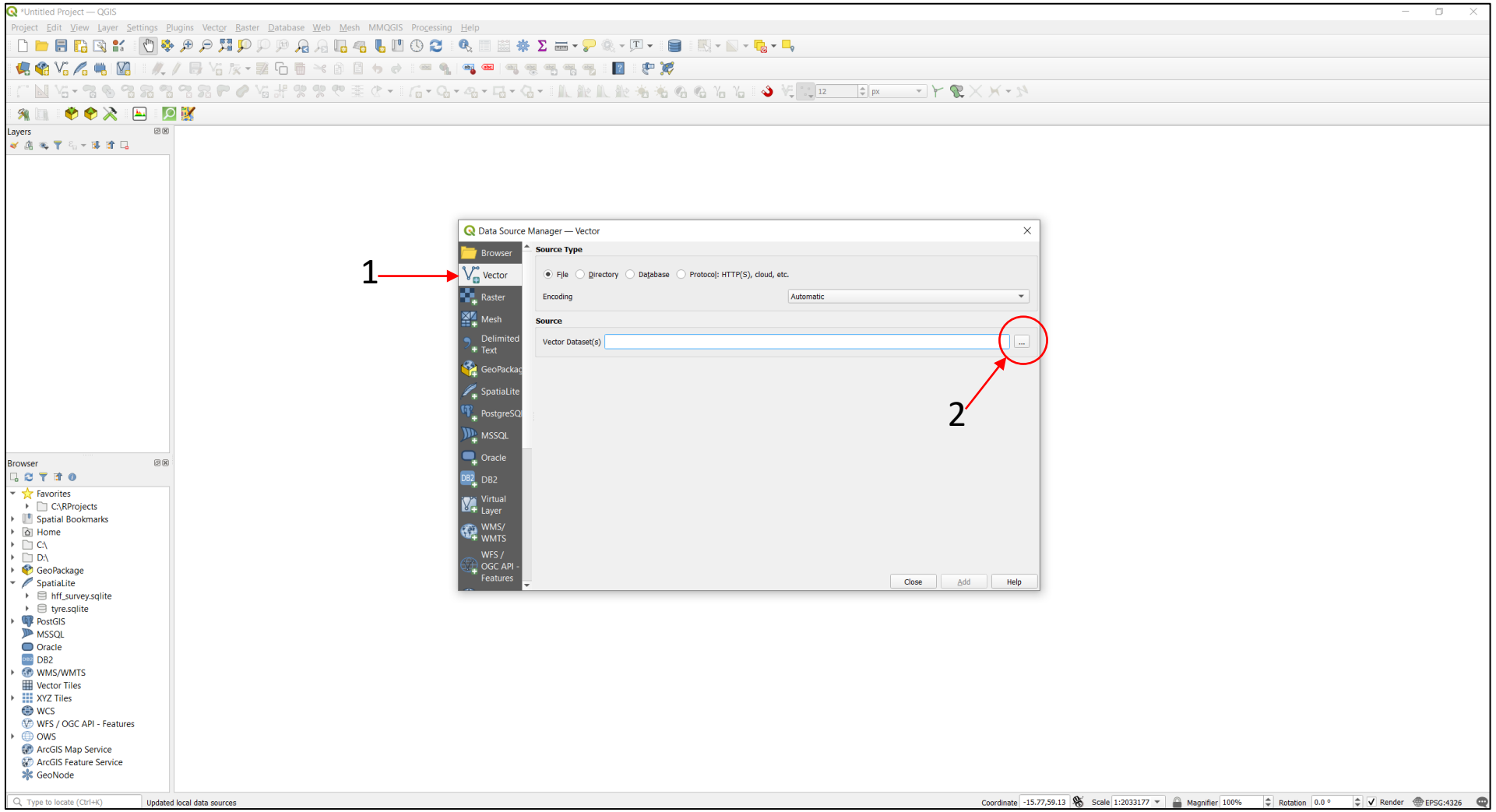
Click on “Open Data Source Manager”



Load Data - Vectors

We have to tell QGIS which kind of data we want to load, this is why is important to know the differences we saw before.

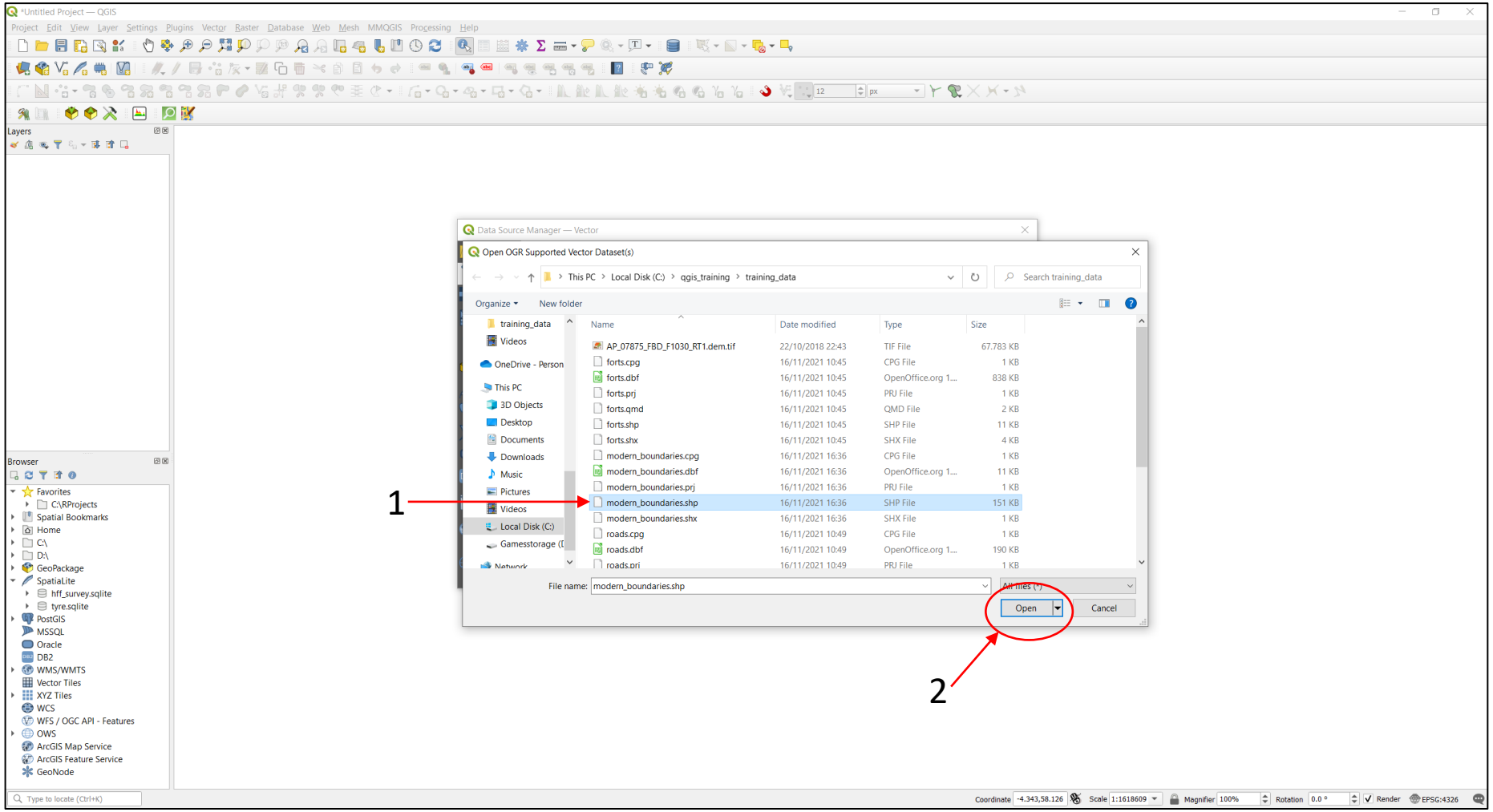
Select “Vector” from the list from the left -> Source Type select “File” -> Click on the three dots under the “Source” menu



Load Data - Vectors

Navigate to the “training data” folder, scroll down and select the **“modern_boundaries.shp”** file from the list of files. Once select it, click on **“Open”**

Before clicking “Open”, take a moment to observe the data named “modern_boundaries”. With any .shp file data there are at least two/three **mandatory** files that must rest in the same folder as the main .shp file (.shx, .dbf, .prj). All these ensures that the vector is displayed and located currently on the map canvas. The .prj file (responsible for storing metadata for the projection systems used by the vector) sometimes is omitted.



Shapefile data structure

Mandatory:

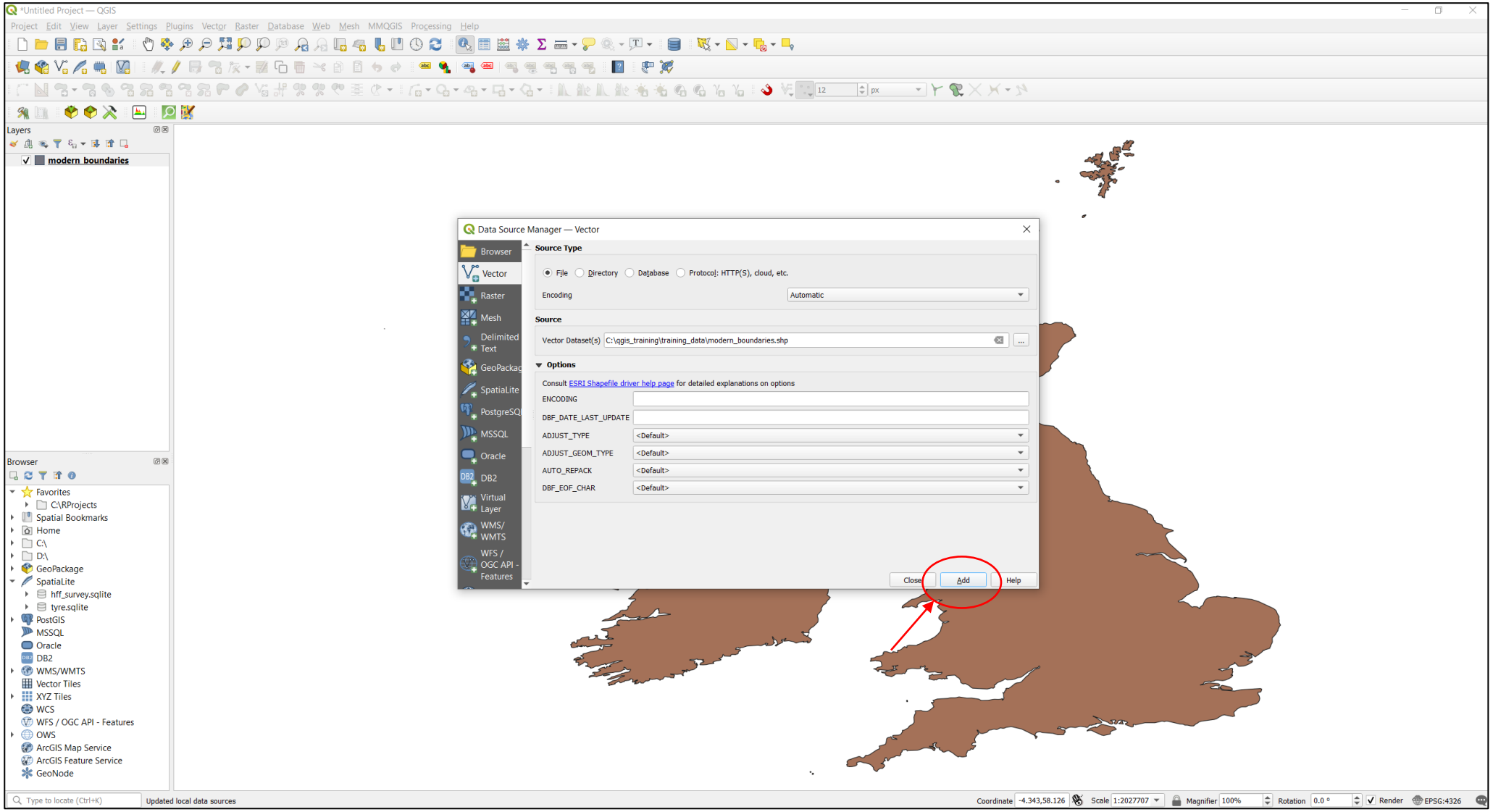
- .shp -> main file
- .shx -> index file
- .dbf -> database file
- .prj -> projection file

Optional:

- .xml -> metadata
- .sbn -> optimizing file
- .sbx -> optimizing file

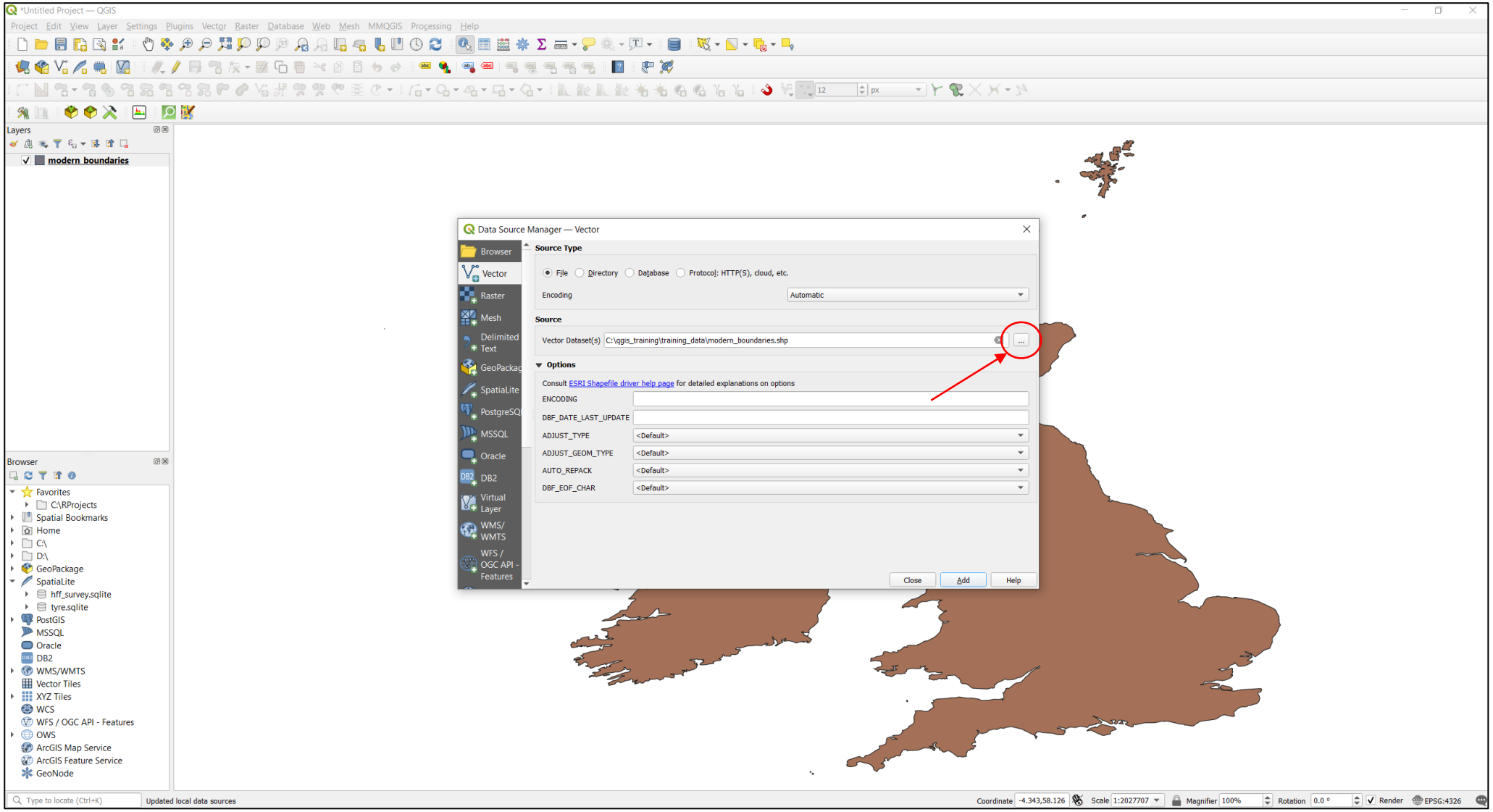
Load Data - Vectors

Leave every option as it is, and click on the “Add” button. You should now see that a new entry has appeared under the “Layers” panel to the left.



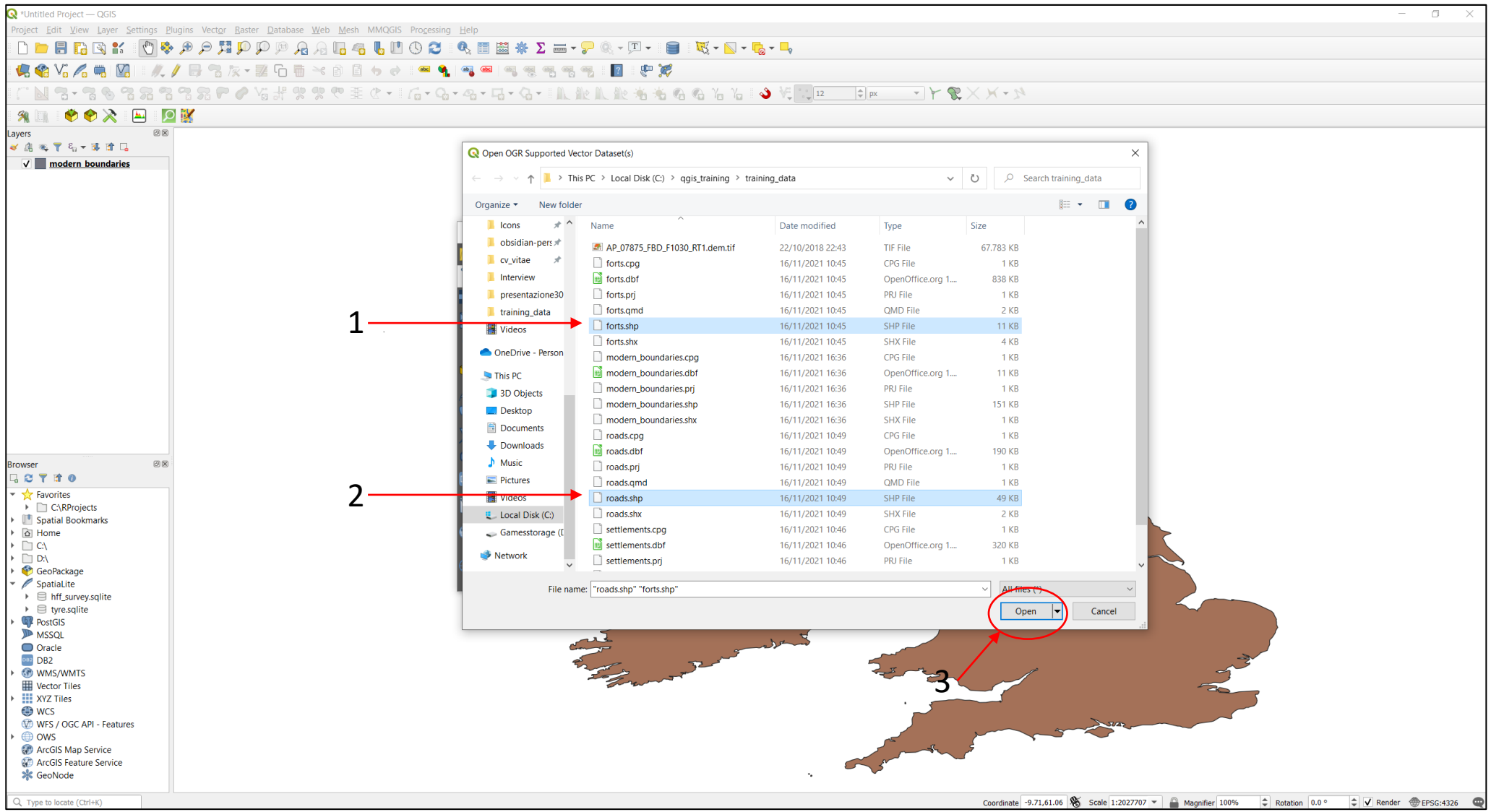
Load Data - Vectors

We can load other data as well. Click again on the three dots under the “Source” menu



Load Data - Vectors

We can load multiple data together. On the new window, select “forts.shp” and “roads.shp” by **holding down ctrl/control** (on a Mac hold down **cmd/command**) and click **“Open”** once again.

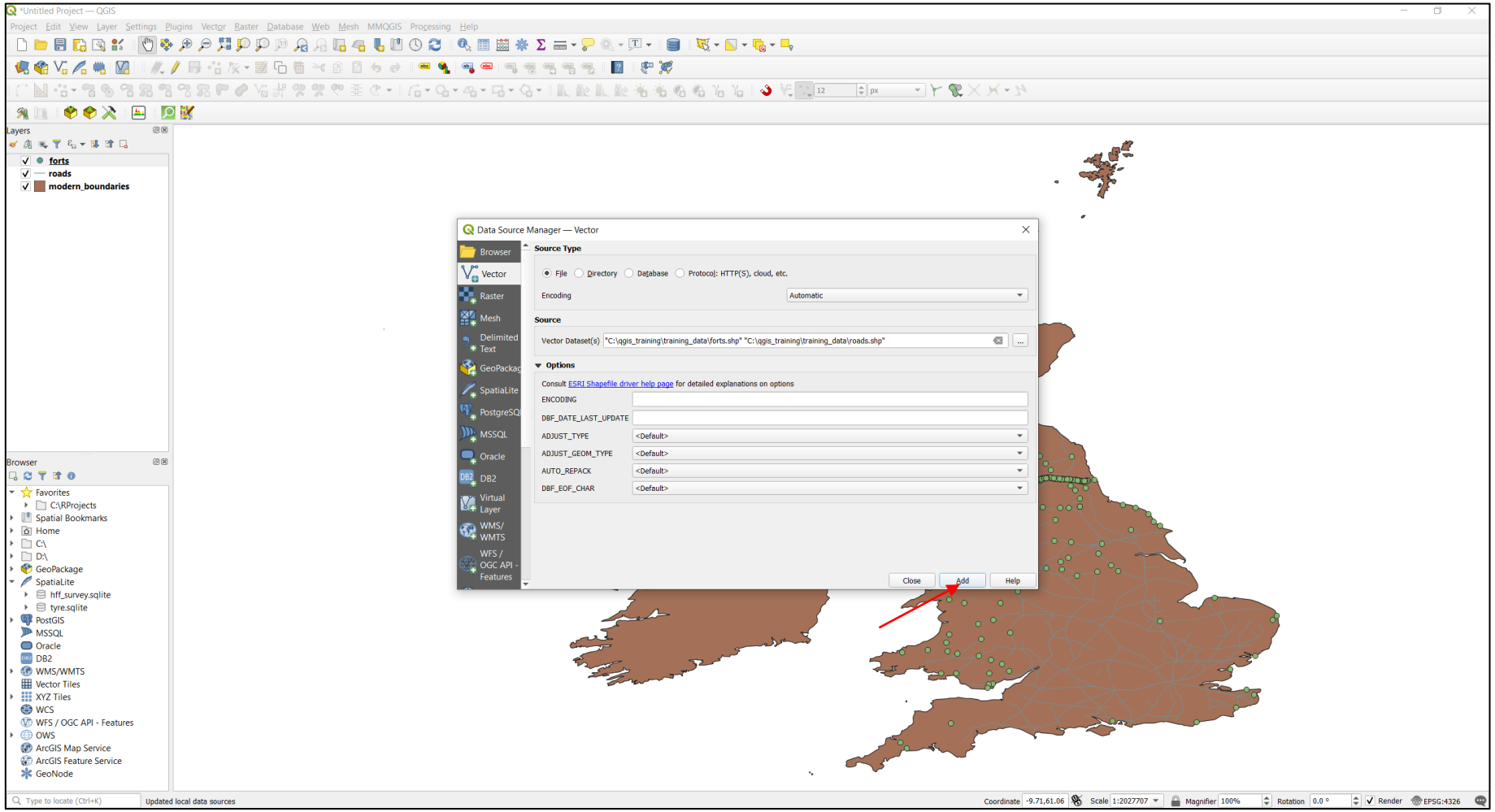


Load Data - Vectors

Click on **“Add”** once again and you should see two new entries in the layer panel to the left.

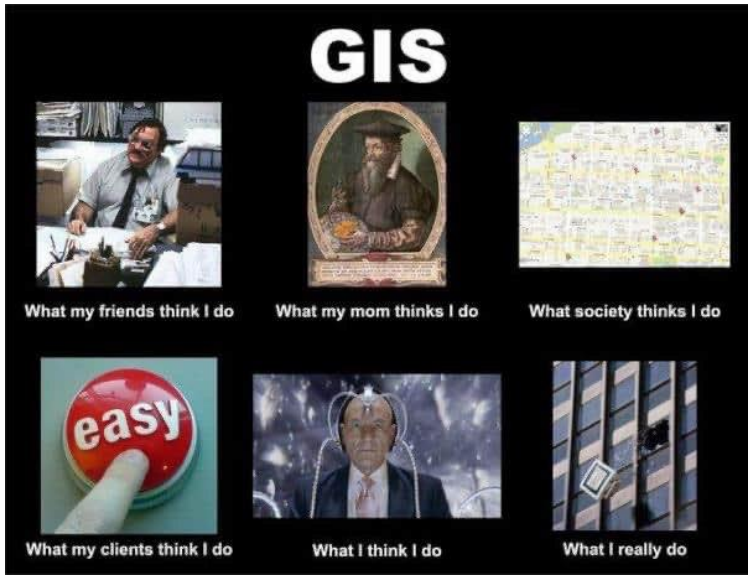
Now we can close the data source manager windows by either clicking **“Close” or the X** on the top right corner.

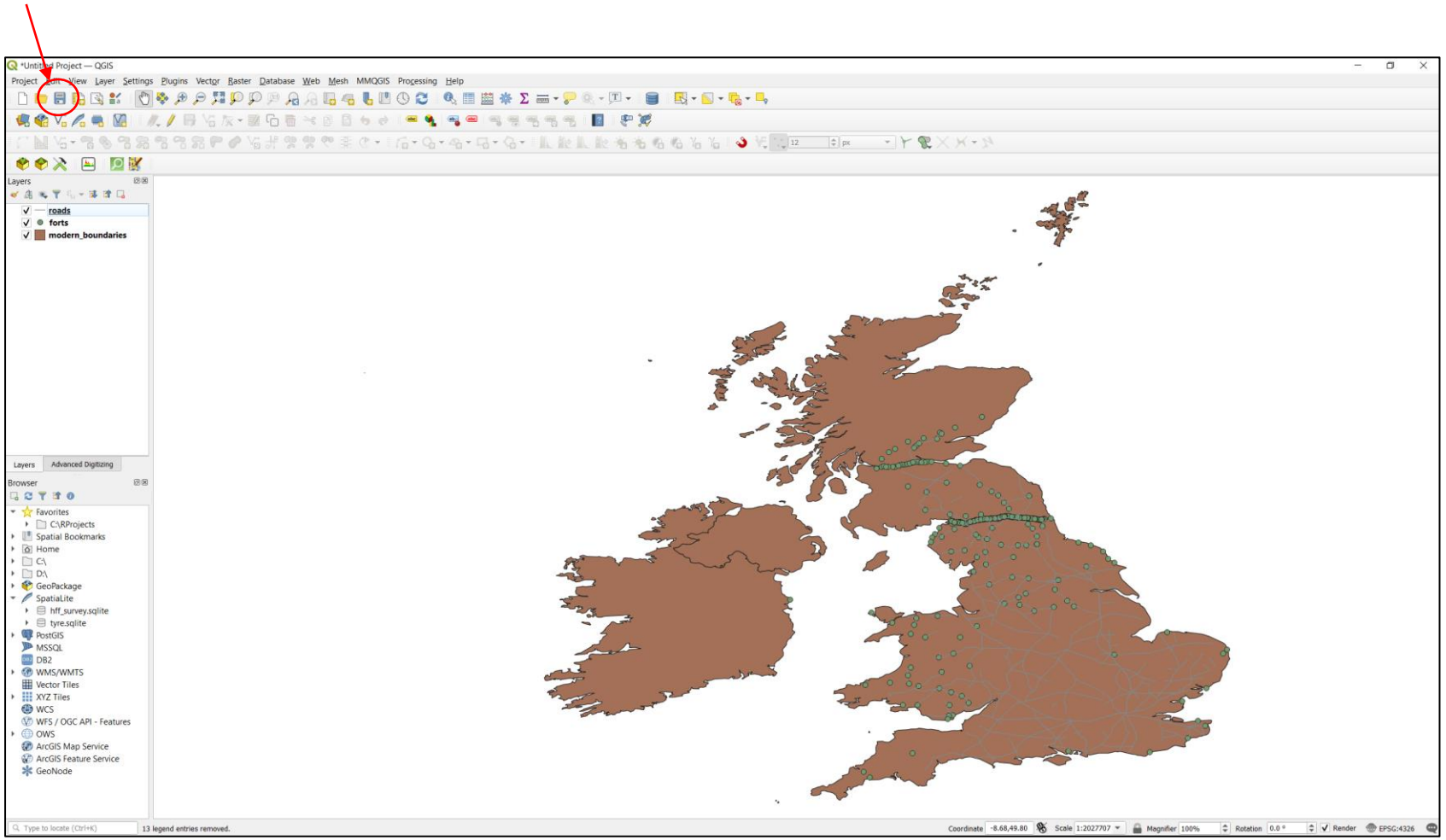
Note how each layer on the left in the Layers panel is represented by a **different symbol**. QGIS is basically telling you what kind of **geometries** these layers are (we have seen these before, vectors can be either points, lines, or polygons).



Save often!

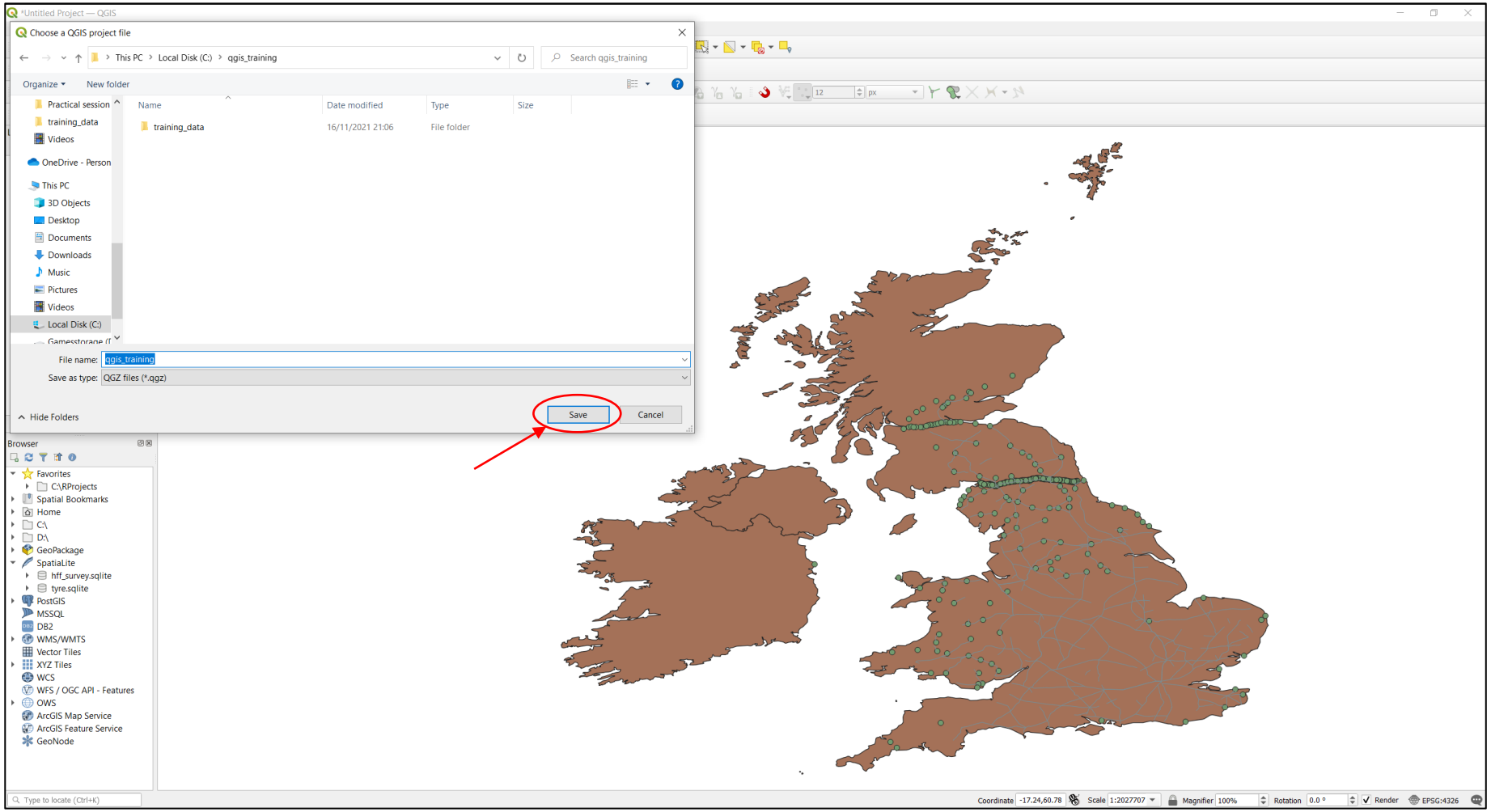
It is normal behaviour for most GIS softwares to sometimes hang or crash. To prevent this, be sure to **save often**.
To save a project in QGIS, click the "**Save**" button, it is the floppy disk button at the top of the toolbar, right under "Edit".





Save often!

A new window should open, select **where** to save your project (best practice: avoid saving to your desktop), give it a **name** (e.g. qgis_training), leave other options as they are and click **"Save"**. (Tip: avoid saving to your Desktop, it can sometimes break links withing qgis with more complex projects)



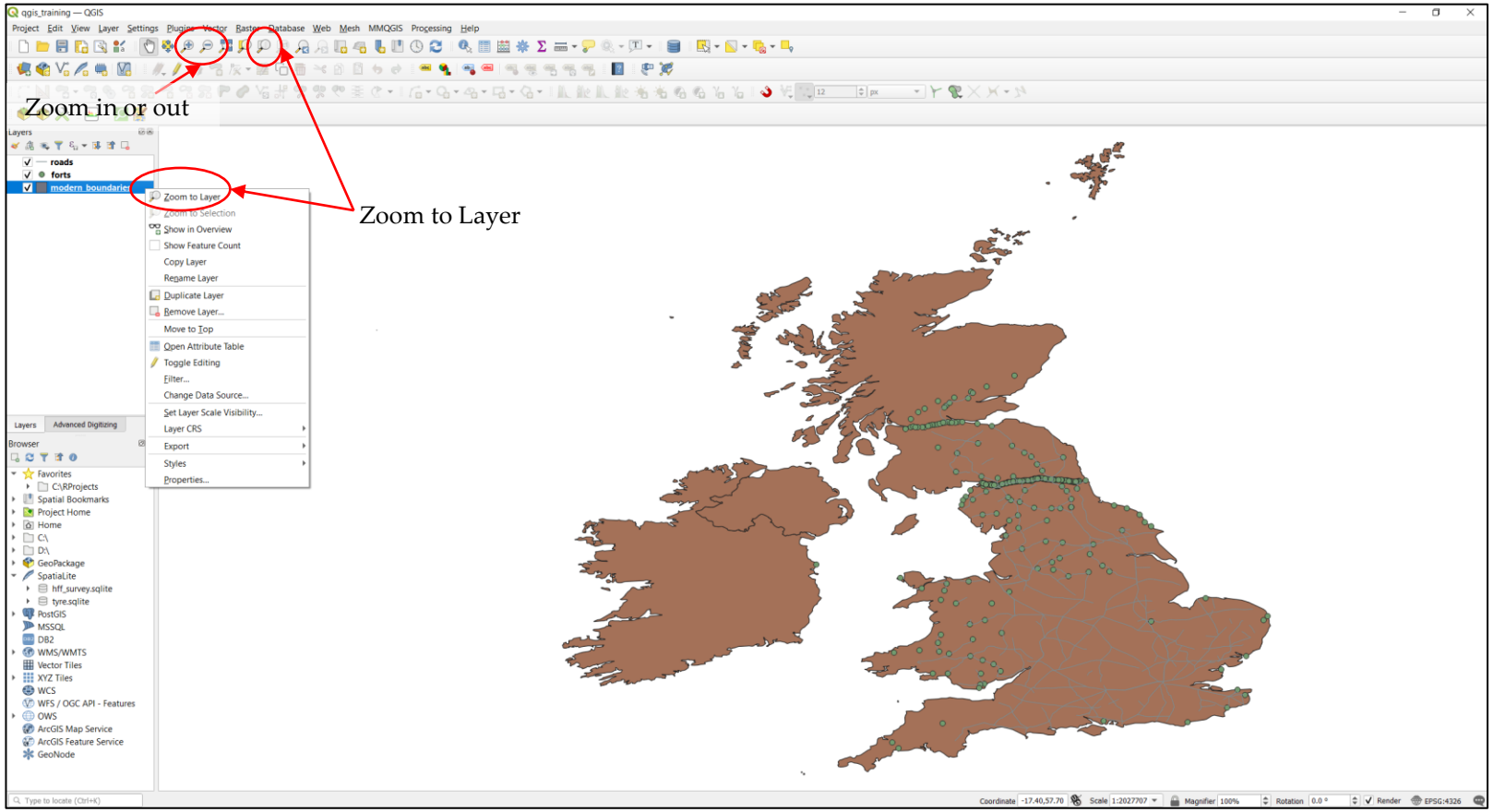
Moving around the map

Note how the name of the project on the top left is now changed as well. Now take a moment to familiarize yourself with the basic controls of the map in qgis. You can see a button shaped like a hand, this is the **pane tool**, select it, and you should be able to move around the map by **clicking and dragging around**. The same result can be achieved when holding down the **middle mouse button and dragging**, even when the pane tool is not selected.

To zoom in, use the mouse wheel, in order to better control the amount of zoom, you can press **control** on Windows an **command** on a Mac.

There is also a **Zoom Tool** that you can use (it is generally easier with the mouse wheel). The zoom tool is found on the top toolbar as the magnifying glass with a "+" or "–" sign to zoom in or out. You can drag and drop to select and area where to zoom in.

Another useful zoom tool is the **Zoom to Layer tool**. You can find it by right-clicking on a layer and select "Zoom to Layer", or at the top of your toolbar (the magnifying glass with a small white box behind it)



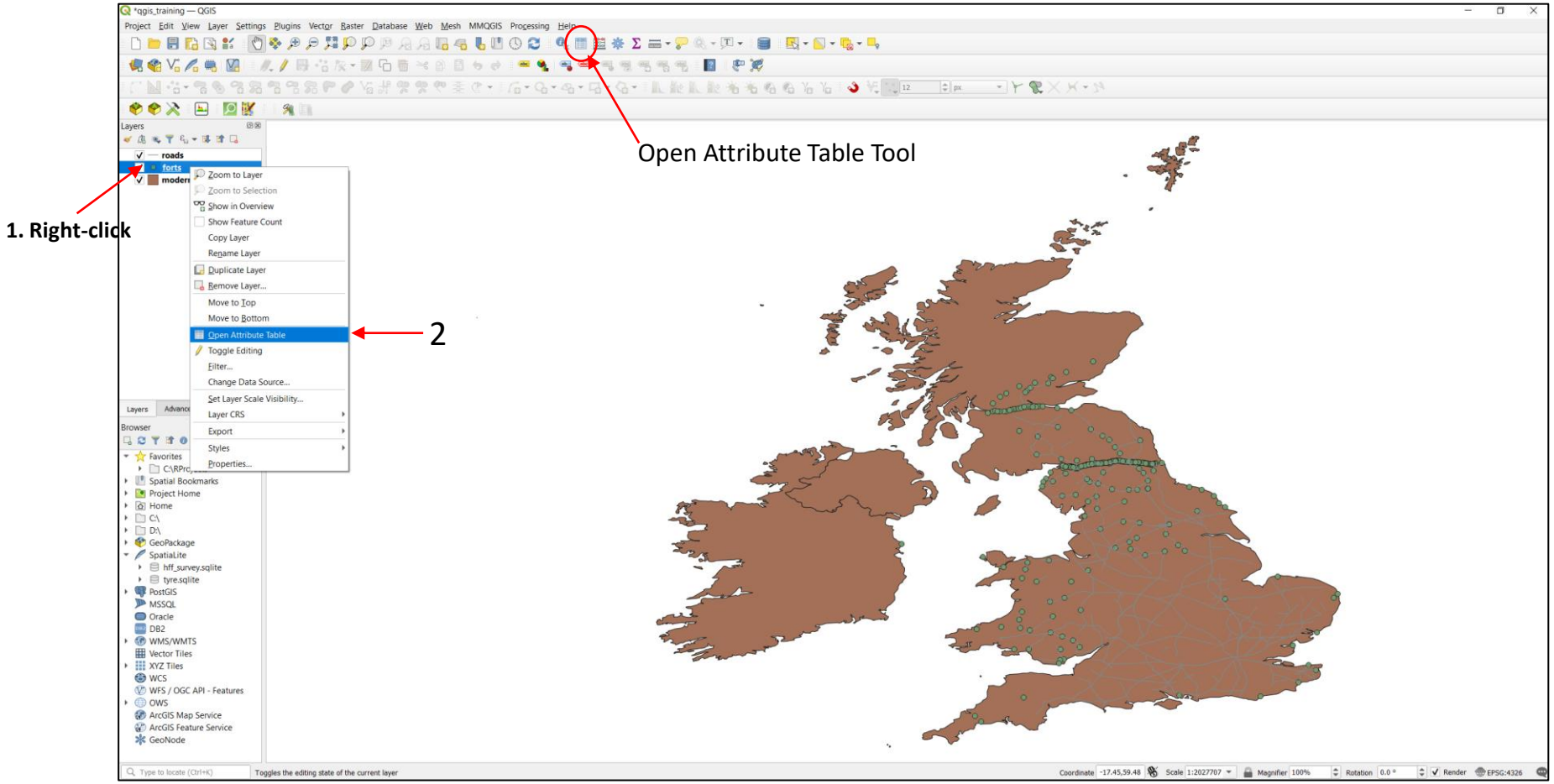
Working with Vectors – Inspect data

Now that we have our data loaded, we may want to actually take a look at the data. It is important to understand **what information are stored** in each data, especially if we are not the authors of those files.

Information on the data are stored, as said before, as **attributes**, which translates in QGIS into as an **attribute table,** unique for each layer, that we can open and inspect.

You can do that by **right clicking** on a layer of choice, e.g. forts, and select "**Open Attribute Table**", in the middle of the popup window.

Another way of opening the attribute table is by clicking the "**Open Attribute Table**" tool in the toolbar on top, which is symbolized by a sort of table.



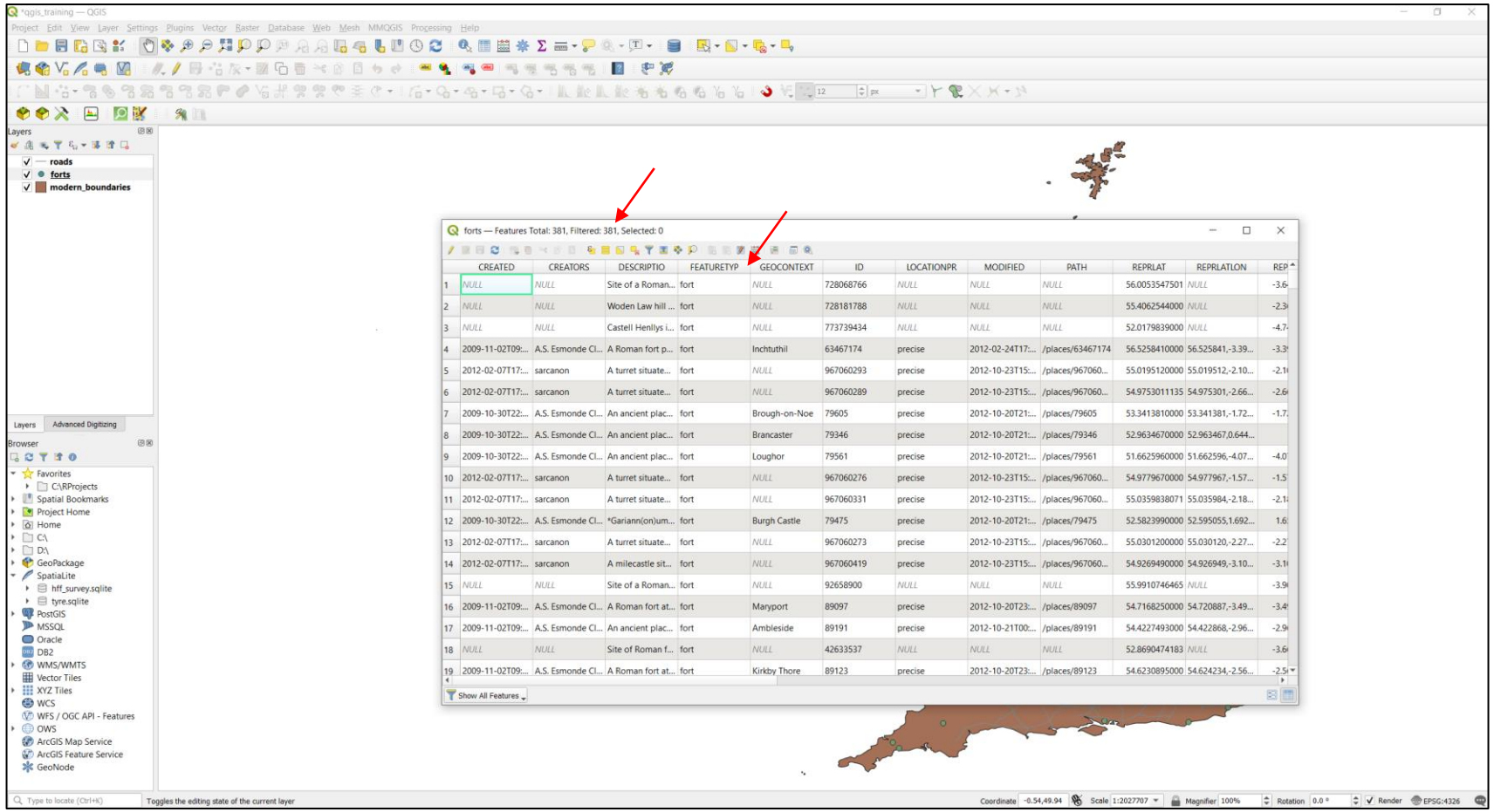
Working with Vectors – Inspect data

Now you should see a new window opening, this is the **attribute table**. As you can see is a sort of excel-like table, with field and info for each point or element contained inside a layer. There is also a **numeric value** at the very top telling you how many feature are stored in that layer (in this case, **the layer "forts" have 381 features**, meaning that 381 forts were recorded in that shapefile).

Information in the table are useful to both the people that created the data, and for users. For example, under **FEATURETYP** we can see that all our observation are listed as "forts".

Information like this are useful when working with thousands of points and when not all of them are the same features.

We can now close the attribute table.

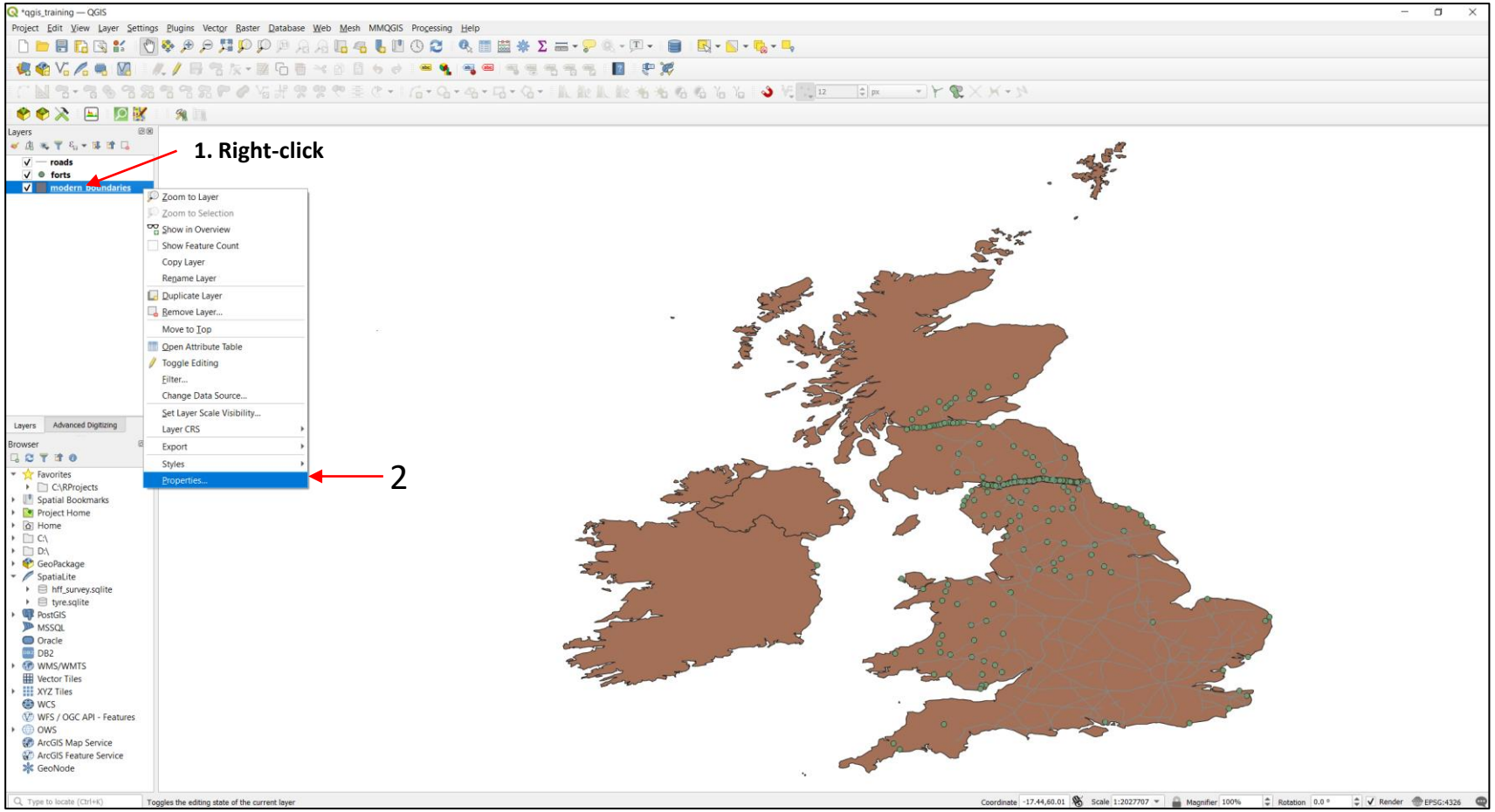


Working with Vectors – Change Layer Symbology

When working in GIS we might want to share our map with other colleagues or using it for a presentation. For the map to be effective, it must be **readable**. To improve readability, the first (and easier) thing to do is usually tweaking the **colours** of our layers.

Tip: start with your lowermost layer, or the layer that cover more of your map canvas, and then tweak the other colours accordingly.

To change colour to a layer in QGIS, you have to **right click** on a layer, in this case we will use "**modern_boundaries**" and click on "**Properties**" at the bottom of the pop-up window.

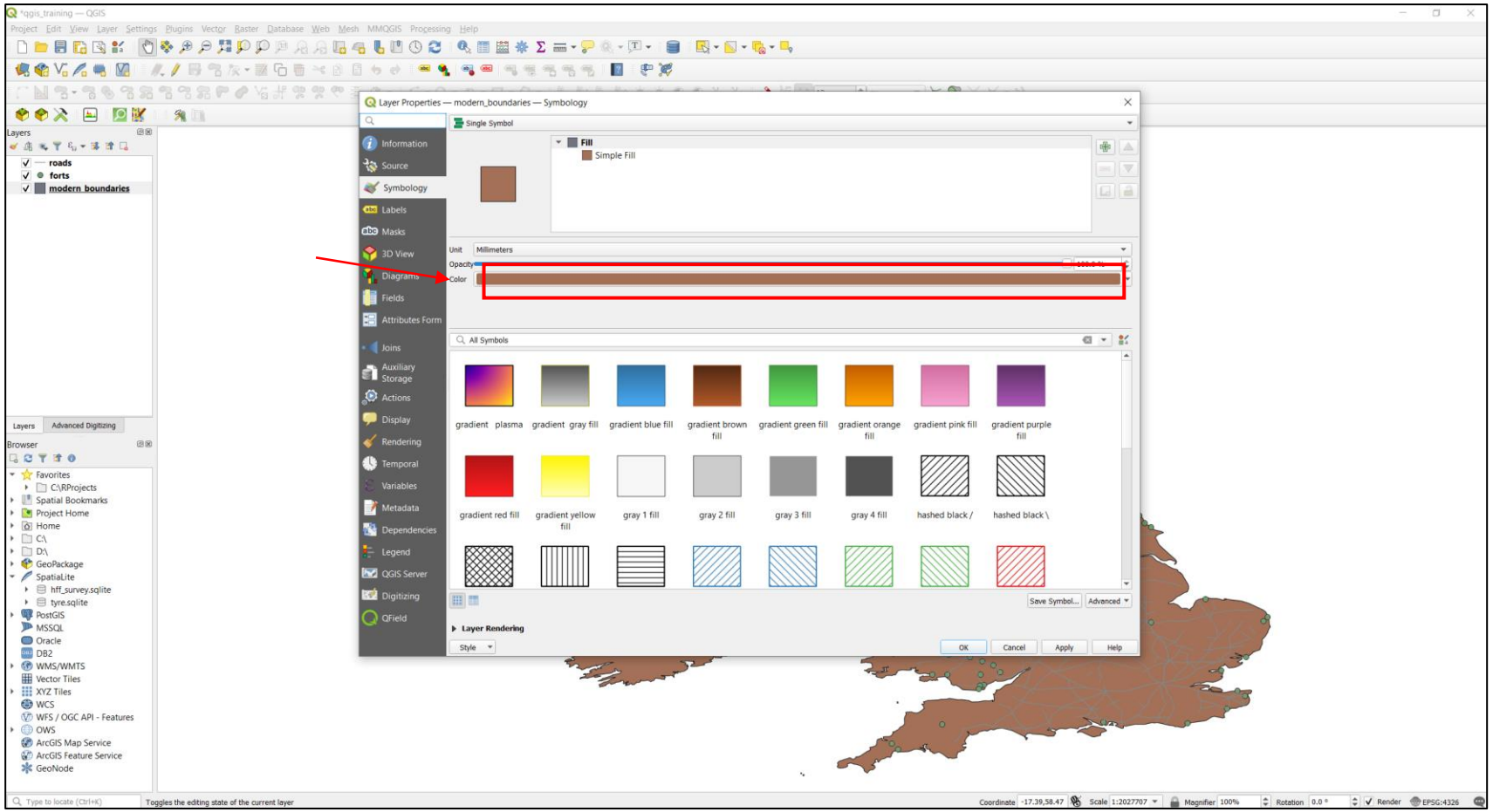


Working with Vectors – Change Layer Symbology

A new window should open, called "**Layer Properties**". If it is not selected by default, select the Sybology tab on the left, under Source.

You can see now that there are a bunch of things here, but the thing we are interested now is **Color**, and you can find it in the upper part of the window, right under Unit and Opacity.

Now click anywhere on the colored bar.

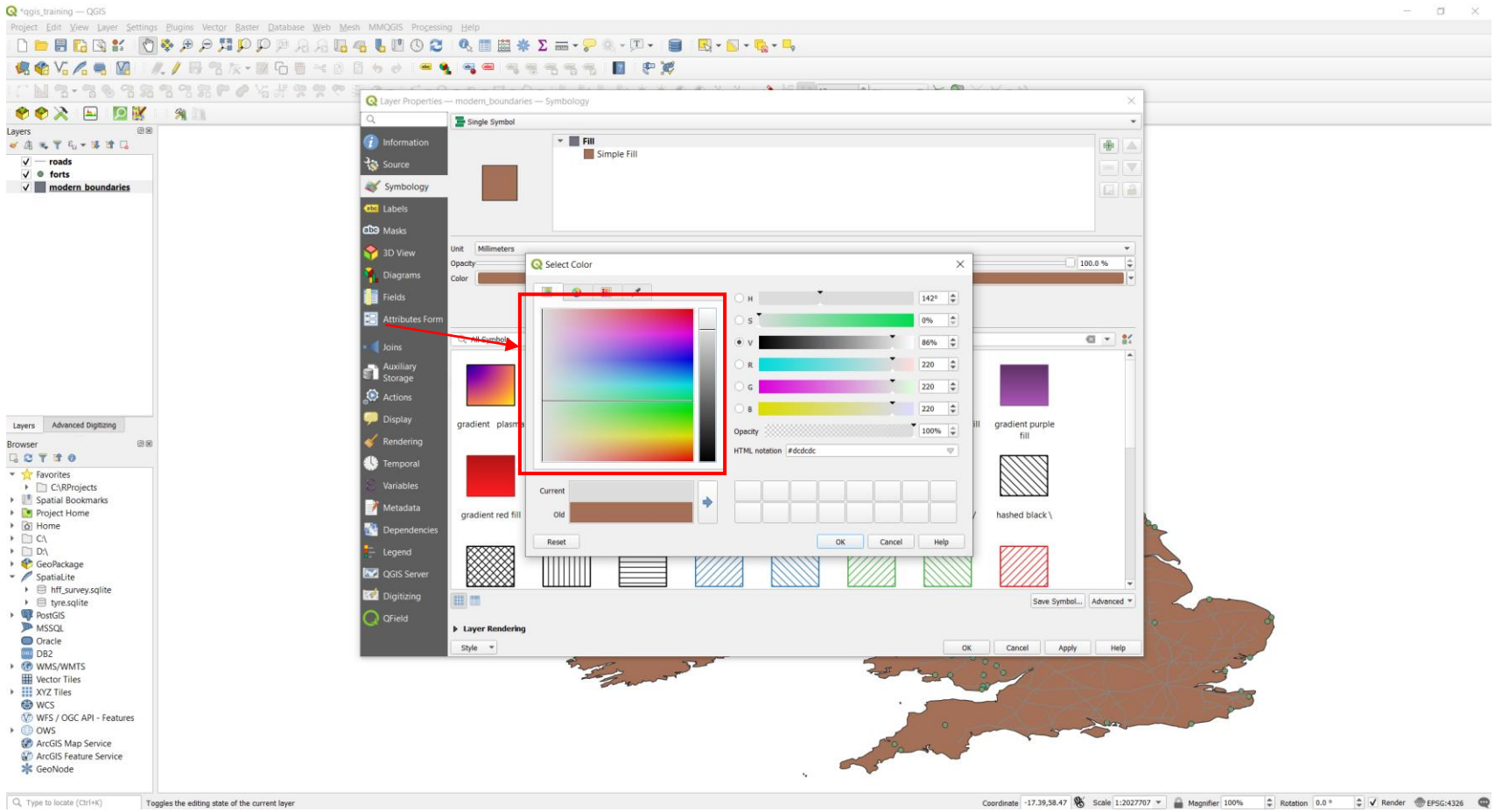


Working with Vectors – Change Layer Symbology

In the new "**Select Color"** window that opens, change color by dragging the **crosshair in the colors square on the left and the slide on its right**, or by changing any value on the bars on the right. You can also simply write an HTML value in the HTML box under "Opacity", it is up to you!

For this presentation, I want to make the boundaries grey, so I play around with the crosshair and the slide to its right, until I get the desired result.

Once you are satisfied with the result, Select **OK** on this window to close it.

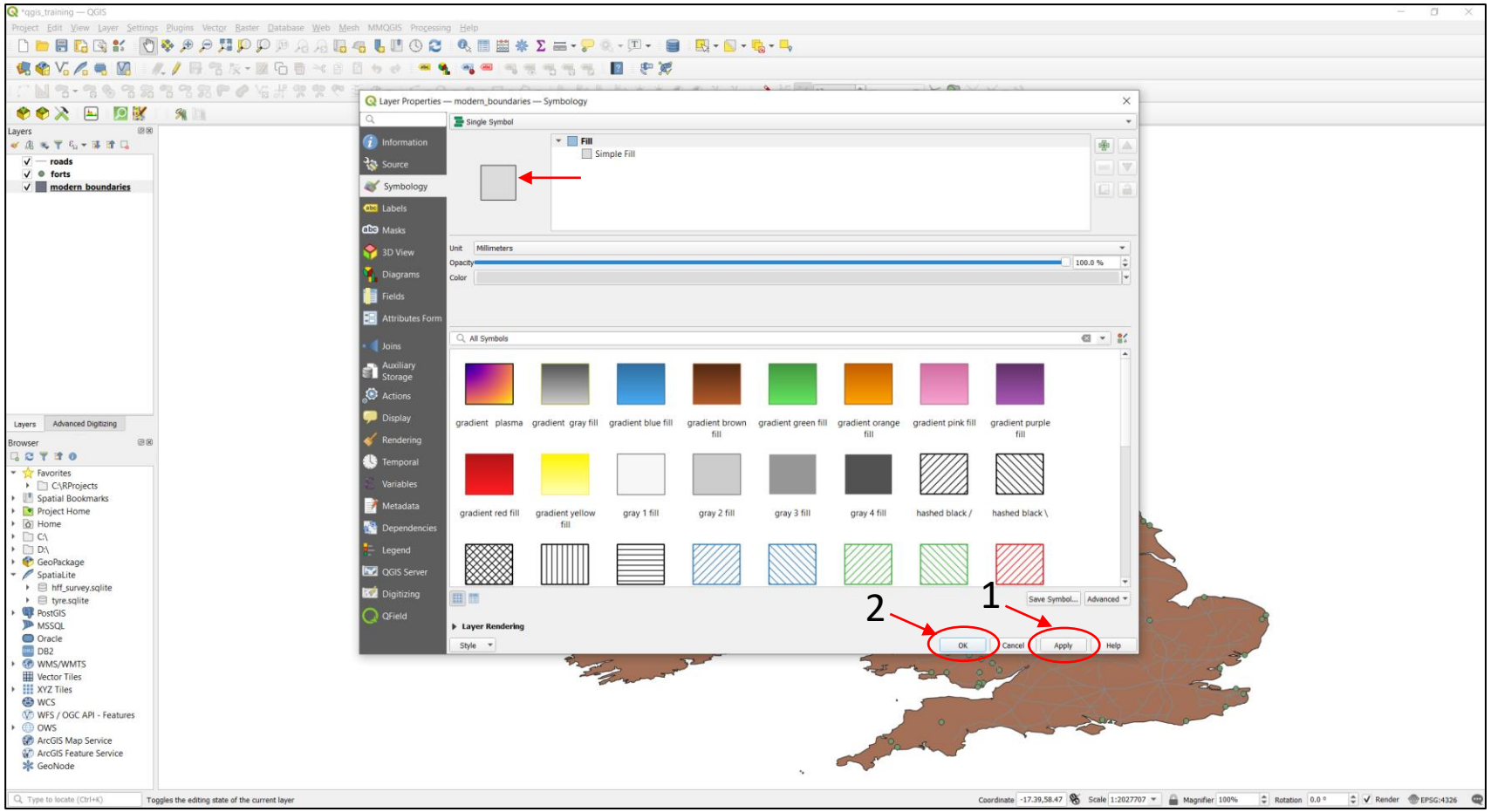


Working with Vectors – Change Layer Symbology

You can see that the colour has changed in the layer properties panel, but not on the map canvas. This is because we have not applied the modified settings yet. When you modify something, **you always need to click apply** for the changes to take effect.

Click now on "**Apply**", and you can see that the colours on the map canvas are changed as well.

To close the Layer Properties window, simply click "**OK**".

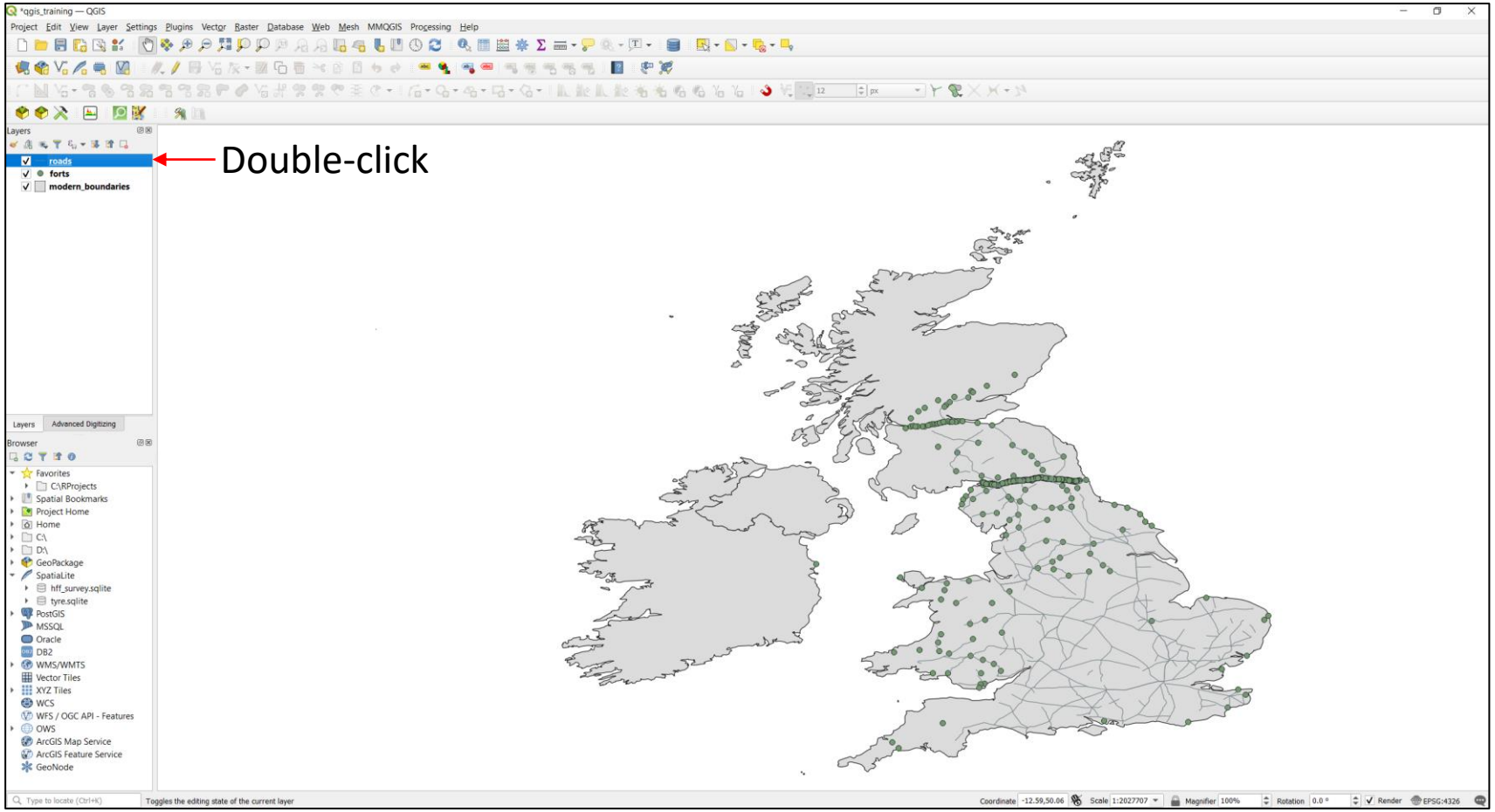


Working with Vectors – Change Layer Symbology

You can see now that all our changes have been applied and are displayed on our map canvas.

We can do the same things to our **roads**, so that they contrast better with the grey background.

To open the Layer Properties panel in a faster way, instead of right-clicking, we can **double-click** on the layer name in the layers panel.

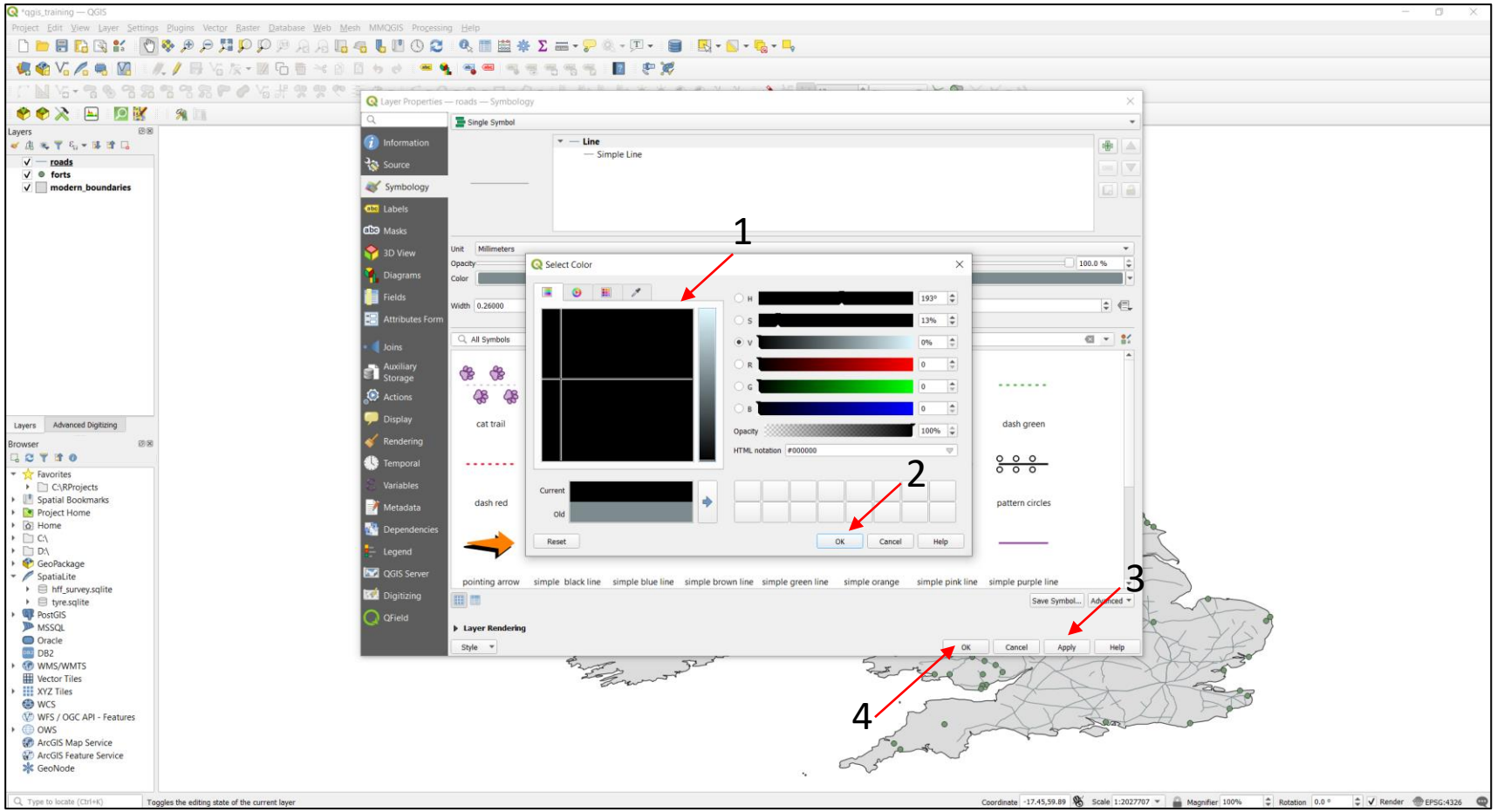


Working with Vectors – Change Layer Symbology

We can change the colour of the roads in the same way we did with the boundaries. Click on the colour bar to open the "**Select Color**" window, and then select a color that fits well for you, in this case I will choose a black color to improve contrast.

After selecting the colour, as before, click **OK** to close the **Select Color** window, and then click **Apply**.

After that, close the Layer Properties by clicking **OK**.

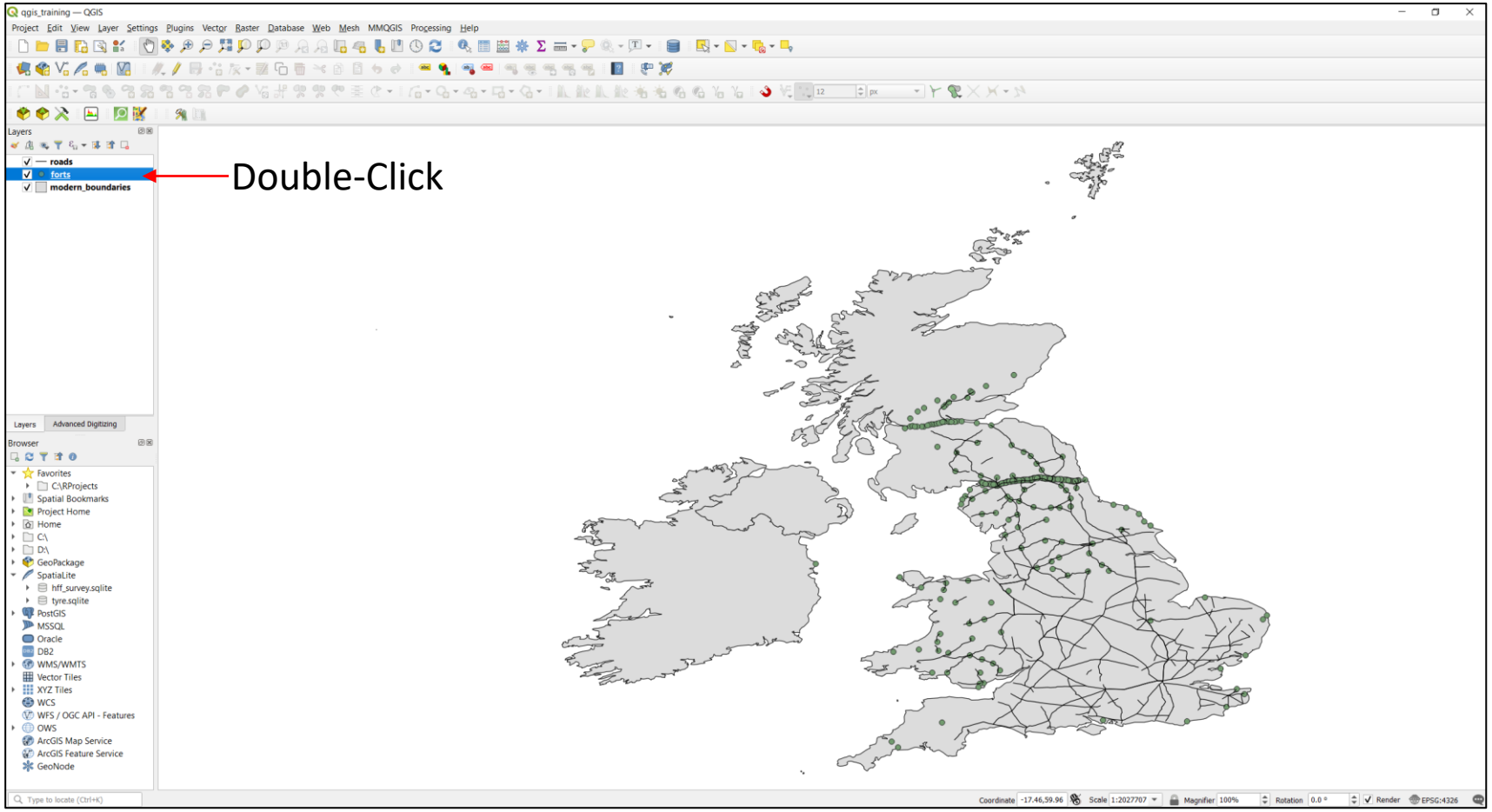


Working with Vectors – Change Layer Symbology

Just to be sure, save your project (click on the floppy disk symbol on the top left of the toolbar).

Another thing that we can do to improve readability, is to change the **shape** of a layer, so that is not a generic set of points, but it is immediately recognizable at first sight (this might be useful for example when you have a lot of layers to distinguish).

Double-click on the forts layer in the Layers Panel.



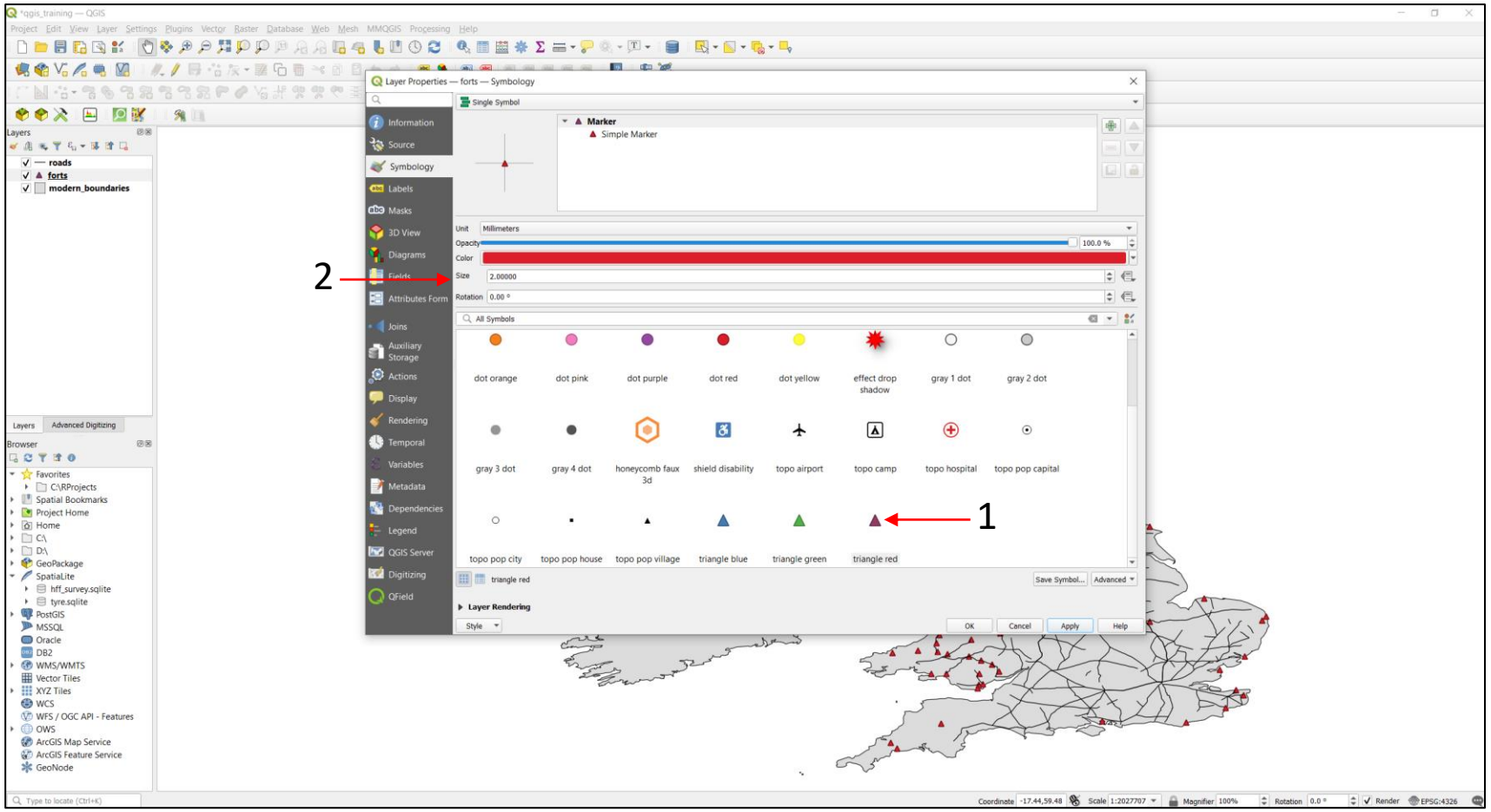
Working with Vectors – Change Layer Symbology

In the Layer Properties window, we don't want to change color now, but you can see that at the very bottom there is a panel with different symbols inside it.

We can scroll down in this panel and select a for example the small square shape called "**triangle red**" at the bottom of the panel.

We should also change the size of the symbol so that it is not too big, and it does cover other features too much.
To do that, change the value in the "**Size**" box, right under the colour bar.

We can now click apply and OK to close the window.



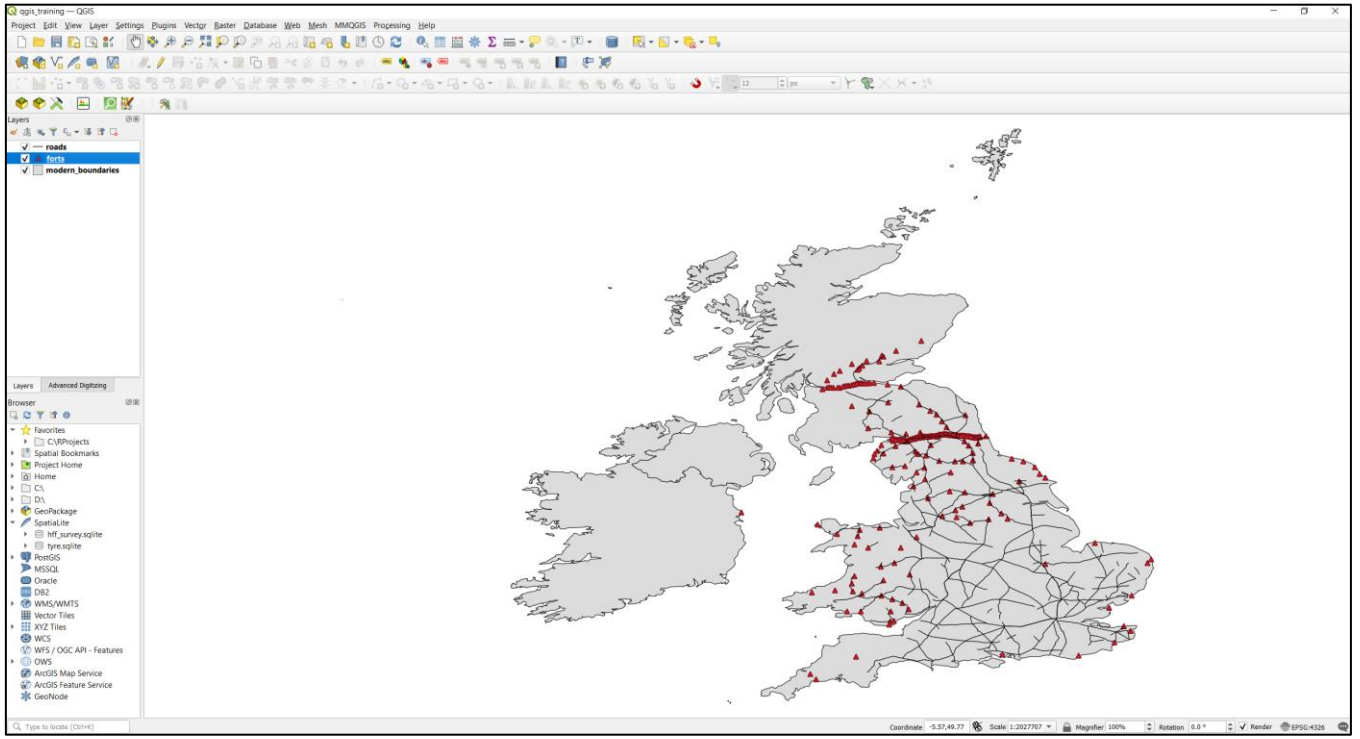
Some Considerations

We now have a more readable map. As you can see thanks to the fact that we have more than one information visible on the map, we can already make some observations.

We can observe how the forts are located in a linear pattern along the roads, especially in the North and to the West. This observation can lead to further questions, were those very important road? What if there were important settlements along them that the forts were supposed to protect?

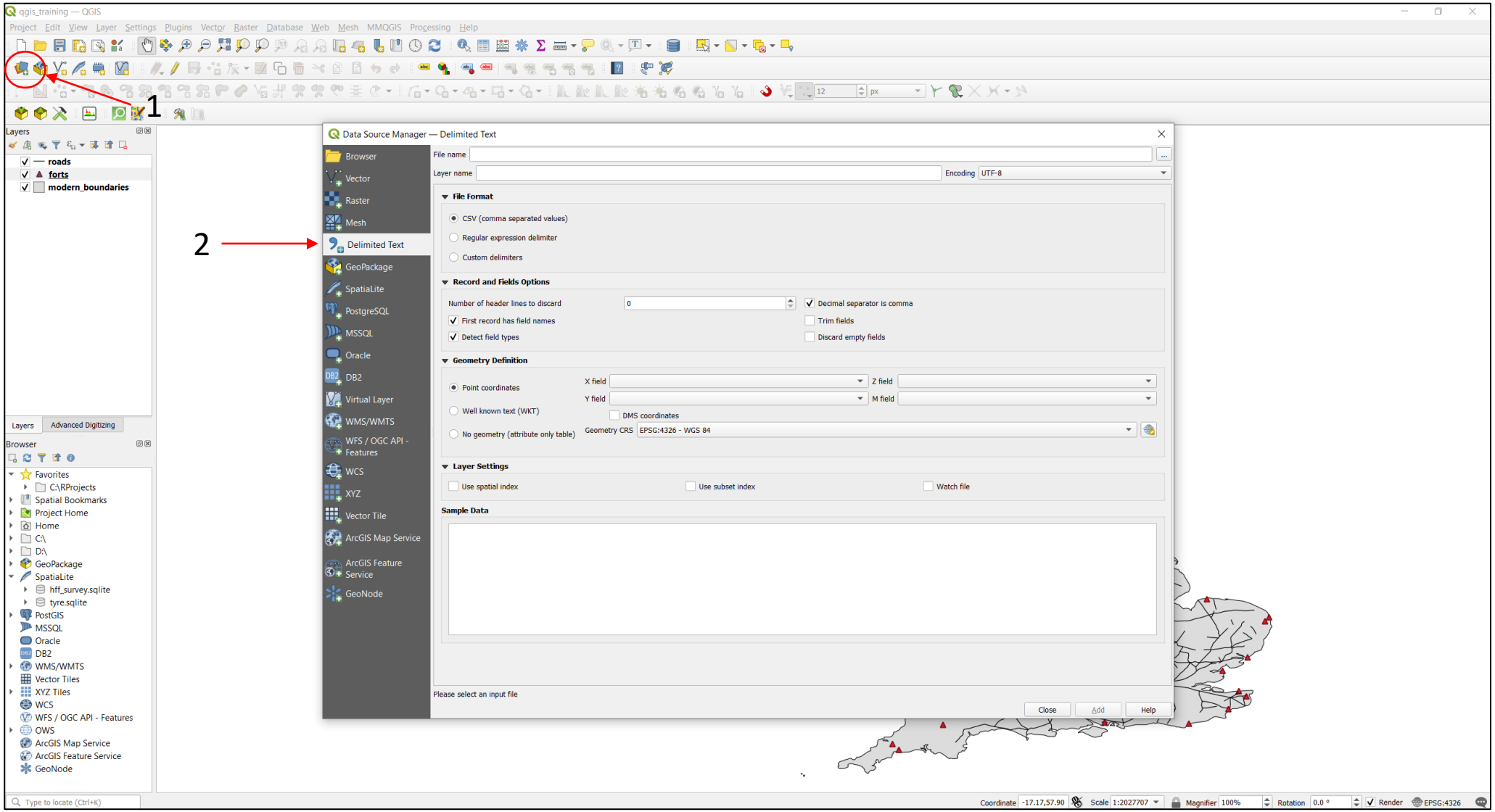
All these observation leads to one consideration about how useful GIS is and what its potential is when using it in archaeology.
Using GIS is an **exercise in observing and understanding the context**, and not only the single, specific data. For example, without roads, we could have only observed how the forts are distributed on the landscape. But this, while important and relevant, is generally not enough, **in order to understand the bigger picture we need to look at the context in which archaeological data are recorded**, especially if we are working at a regional/national scale.

As you have seen, this is somewhat already possible just with a handful of data.



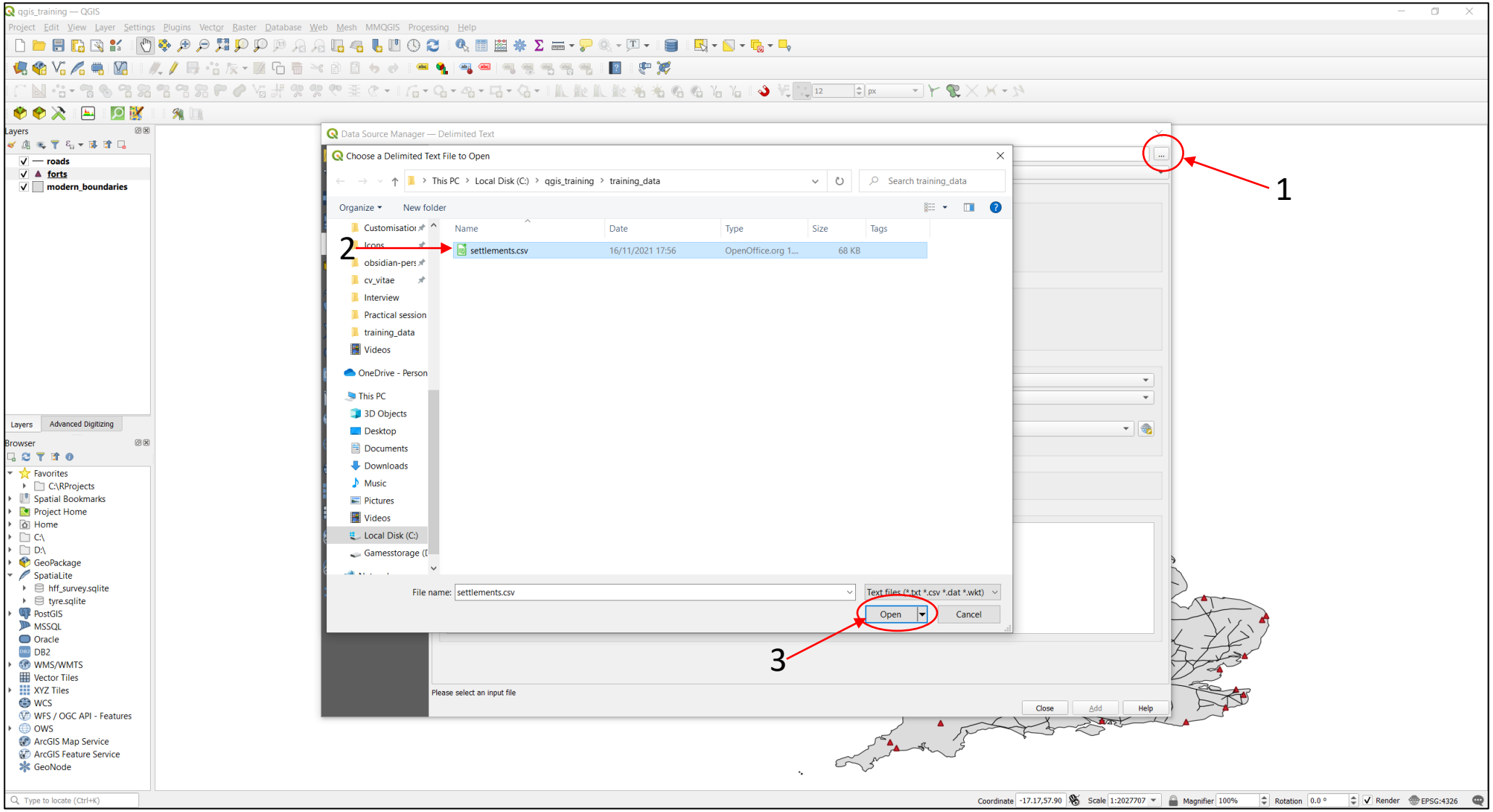
Load Data – Vectors - CSV

As mentioned earlier, another common file type is **CSV (Comma Separated Value)**, these can be generated e.g. from an Excel file. We can load CSV files in QGIS by clicking again on **"Open Source Manager"** button on the top left, and then clicking on **"Delimited Text"** in the left toolbar of the new opened window.



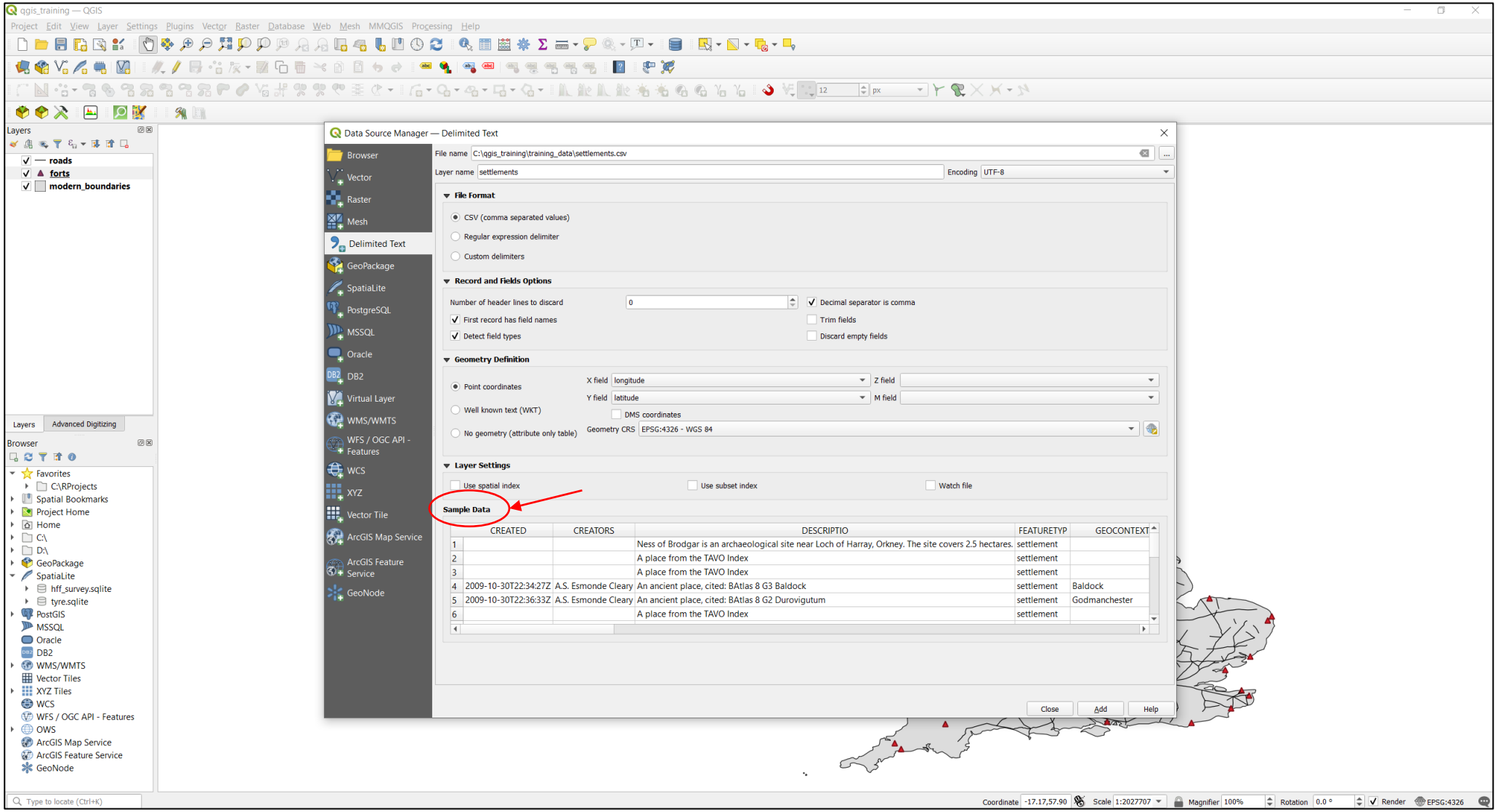
Load Data – Vectors - CSV

Click the **three dots button** and browse to the same folder as the previous data. Select **settlements.csv** and click **"Open"**



Load Data – Vectors - CSV

You can see now there a lot more option and things on this windows compared to the vector data. Usually QGIS is smart enough to read the CSV and adjust settings automatically. However, we need to check a couple of things to make sure that everything will be displayed correctly. Note how you can have a preview of the data structure under **"Sample Data"**



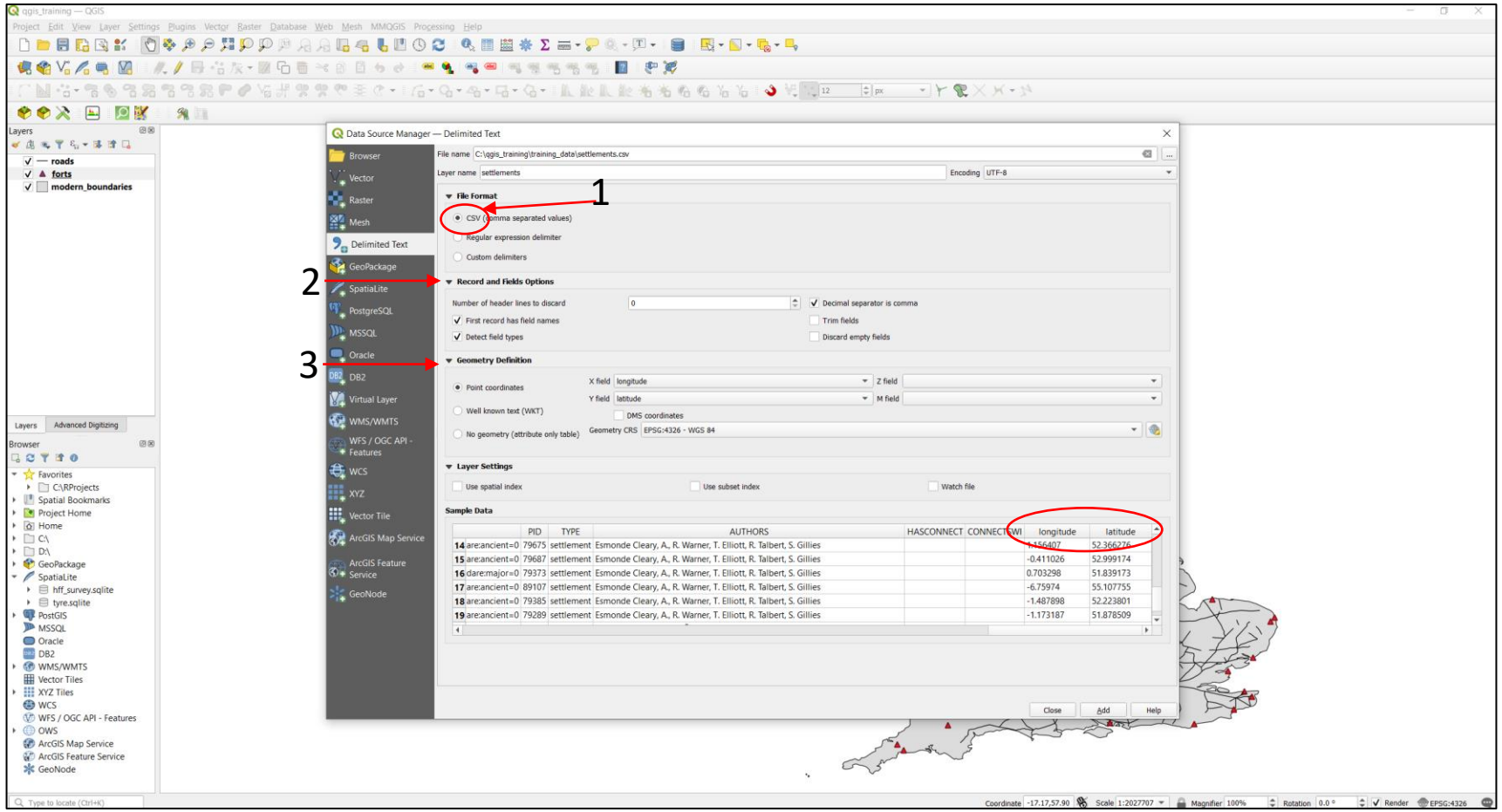
Load Data – Vectors – CSV

Under "**File Format**", select **CSV** (tip: sometimes when your computer is not using English language, CSV might get messed up, if your file is not displayed correctly, select "Custom delimiters" and play around with the delimiters until the "Sample Data" Tab displays the file correctly).

Under "**Record and Field Options**", make sure that "**First record has field names**", "**Decimal separator is comma**", and "**Detect field types**" are checked.

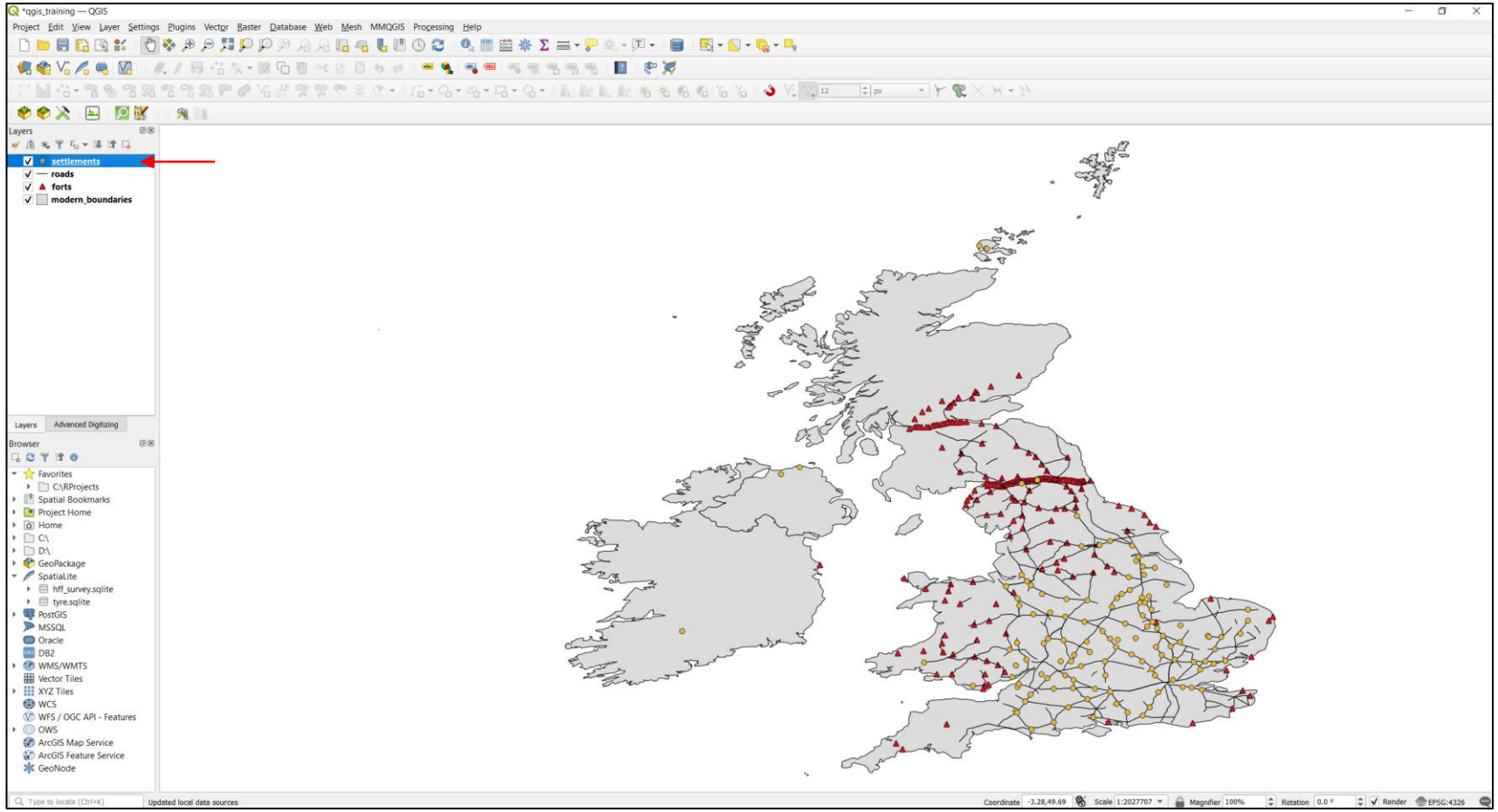
Under "**Geometry Definition**", select "**point coordinates**" and in X field choose **longitude**, and in Y field choose **latitude**. This is **mandatory** for the points to show up! If your CSV file has no fields for coordinates, it will only appear as a table in the layers panel (Rember from the beginning: geographical coordinates are what turns simple data into spatial data, thus GIS-readable).

You can look at the longitude and latitude fields in your file by scrolling to the right with the bottom bar under "Sample Data".



Load Data – Vectors – CSV

Click “Add” at the bottom and close this panel.
You can see that a new point layer has been added to the layers panel to the left, and on the map canvas as well.



Useful Links

Links to download this presentation in ppt or pdf:
https://github.com/andreatitolo/qgis_training_data/raw/main/AT_Introduction_to_qgis.pptx
https://github.com/andreatitolo/qgis_training_data/raw/main/AT_Introduction_to_qgis.pdf

Link to download the data used for this presentation:
https://github.com/andreatitolo/qgis_training_data/raw/main/training_data.zip

The original data can be downloaded at:
Ancient World Mapping Center: http://awmc.unc.edu/wordpress/map-files/
NaturalEarthData: https://www.naturalearthdata.com/downloads/

QGIS Website: https://qgis.org/en/site/

A Gentle Introduction to QGIS (very useful, well-explained clear examples and a few exercises):
https://docs.qgis.org/3.16/en/docs/gentle_gis_introduction/index.html

QGIS Documentation: https://docs.qgis.org/3.16/en/docs/index.html

QGIS Training Manual: https://docs.qgis.org/3.16/en/docs/training_manual/index.html