Geographic Information for Vector Surveillance

Day 1 of a 3 day course with Malaria examples

An Introduction to GIS and QGIS

Learning objectives

- understand what is meant by 'GIS'
- become familiar with the different types of spatial data
- learn how to install QGIS and become familiar with its layout
- be able to change the size and colour of points within QGIS
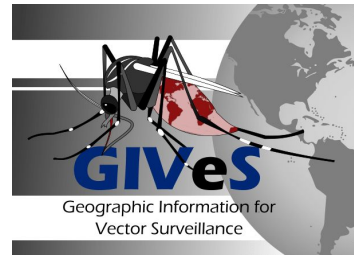- produce a simple map of entomological data within QGIS

Length :   1 day
QGIS version :   3.2
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Updated :   November 2018
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Training materials

Datasets used in the examples are available for download from :

http://etch.lstmed.ac.uk/projects/associated-projects/gives

For this course examples are based around the control of malaria and malaria vectors. Details of the files provided are listed below.

Folder contents

We have provided a folder called QGIS_Training, within this there are four main folders: data, materials, my-work, and software.

- ❖ Data: contains all the data we will be using for the examples throughout this course. This is divided into three further folders: excel, logos and spatial.
- ❖ Materials: contains an electronic version of the manual, copies of any presentations given, and a QGIS project file for the first day.
- ❖ My Work: a place to save and easily retrieve your work during this course.
- ❖ Software: QGIS Installation files.
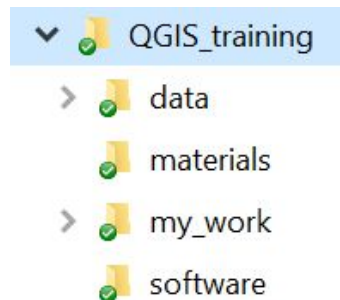
File structure

Having a clear file structure is always useful, but it is particularly important to pay attention to where you save files when working with QGIS. QGIS does not store data within the software, but rather 'points to' the location where the file is stored on your computer. Therefore, if you move a file in between QGIS sessions, you will have difficulties when opening your project. (You will be prompted to browse and locate them, if you do not do this QGIS will not know where to find them and will not be able to display them). For the purpose of this course, we have provided files within a structure, as outlined above. You do not have to use this specific structure going forward, but we do recommend you create a file structure that works for you and that you then maintain that as far as possible.

QGIS

In this course we will be using QGIS, an open-source GIS software that is freely available to download from www.qgis.com.

For this course, we will be using version 3.2.3 (Bonn), recently released in September 2018. Version 3 is due to become the long-term release in February next year and there are some noticeable differences to version 2, so we are recommending you start with version 3. If you are using an older version, some of the screenshots and instructions will differ slightly.

QGIS is maintained by volunteers, and has a vast online community and support network which can be easily accessed if and when QGIS assistance is needed (https://www.qgis.org/en/site/forusers/support.html).

There are also an enormous number of optional additional features that can be added to QGIS using 'plugins'. These are usually written by QGIS developers, and can be added into the software manually with a few clicks after you have installed QGIS on your computer. We will be demonstrating a few plugins during this course.
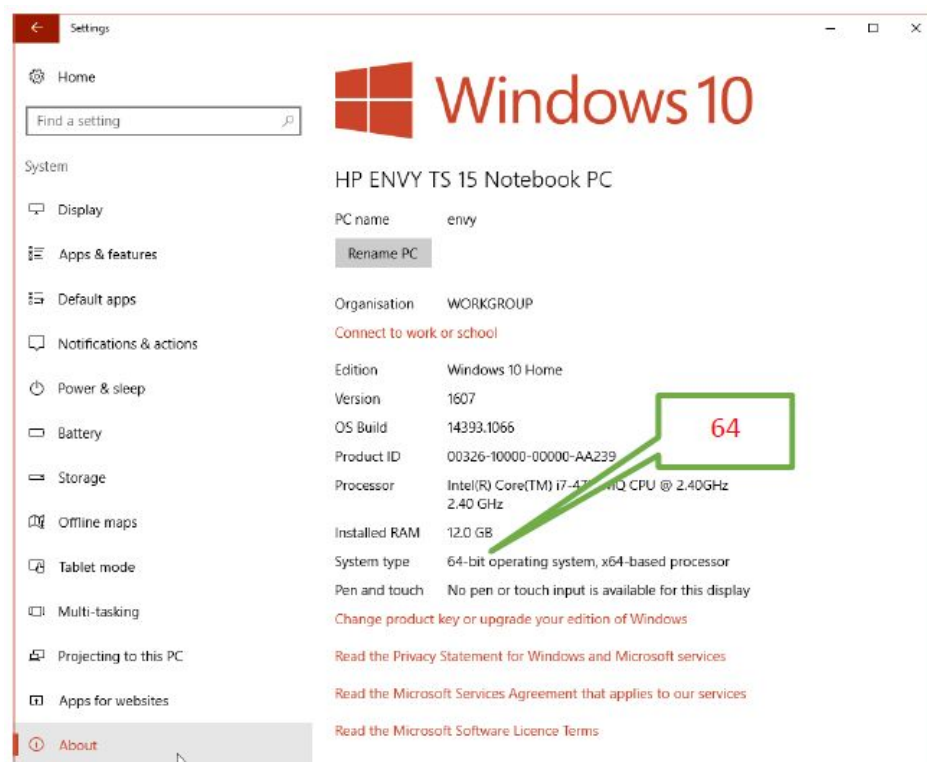
How to install QGIS

The QGIS software is freely available to download from the internet. To save time, we have provided you with copies of the installation files on your USBs in the folder "software".

There are three QGIS installation files provided. The file ending in ".dmg" is for installation on a Macintosh. The two ending in ".exe" are for PCs, one ends in "…x86.exe" and the other in "…x86_64.exe". Which you choose will depend on whether the processor of your computer is "32-bit" or "64-bit".

If you are not sure which your computer has, you can verify this by clicking on the Windows icon in the bottom left-hand corner of your screen and searching for "system" to bring up the system information window, or looking for it manually within in Settings/System/About.
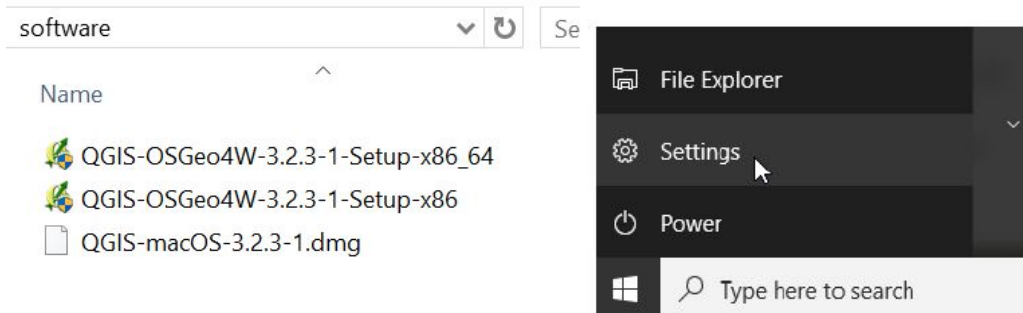
The system information screen will appear something like this:

Once you have confirmed which file you require, the steps for installation are detailed below.

Windows
To install QGIS, double-click on one of the installation files provided in the USB in the folder "Software". Select :

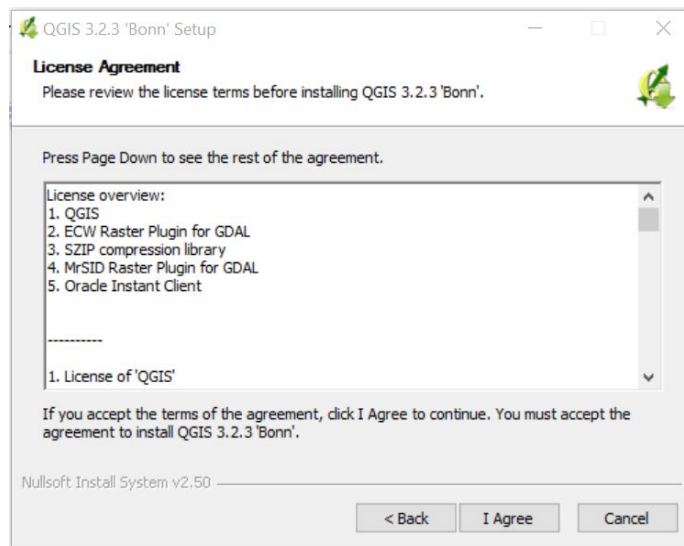QGIS-OSGeo4W-3.2.3-1-Setup-x86_**64**.exe if your PC is **64-bits.**
OSGeo4W-3.2.3-1-Setup-x86.exe if your PC is 32-bits.

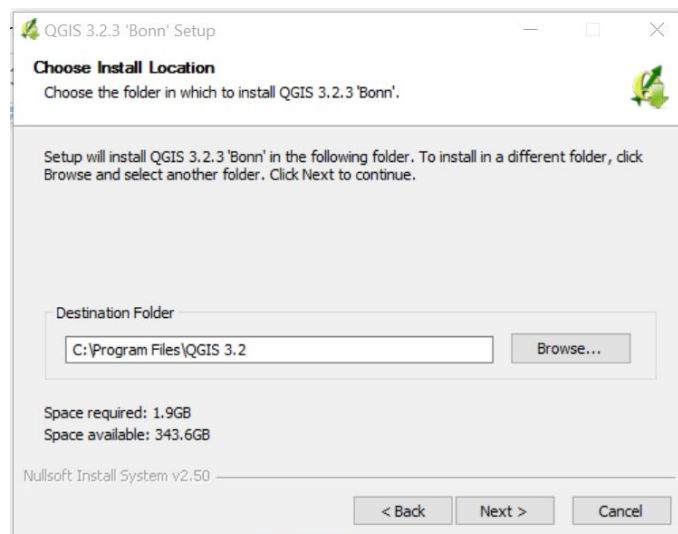(See above guidance on how to check your PC system information)

After accepting the first question window you should get a window like this :
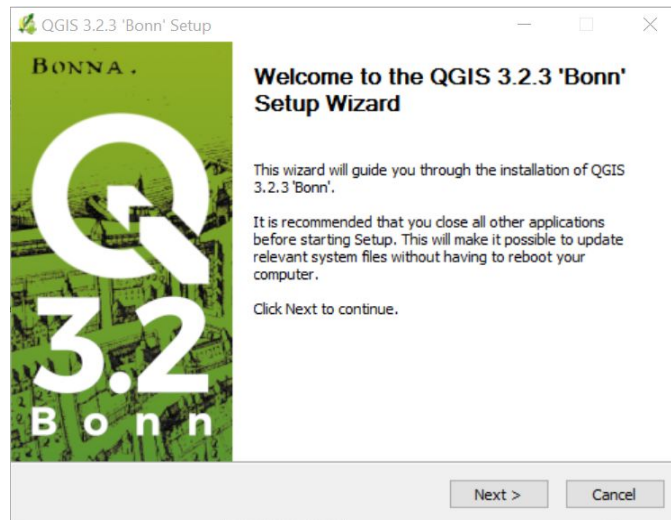
➔ Click 'Next'
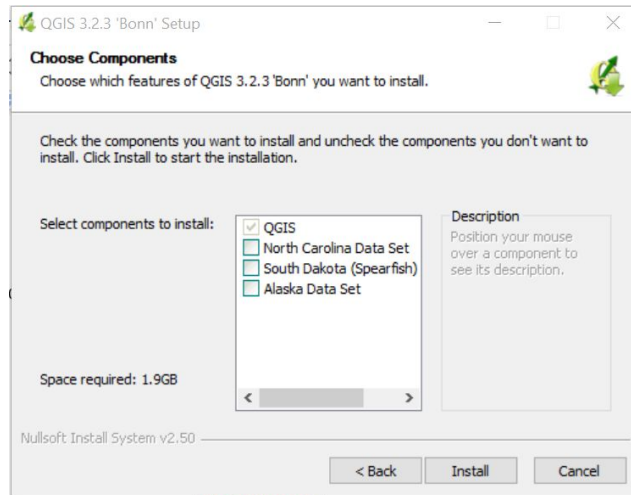➔ Click 'I Agree' on the Licence Agreement that follows,
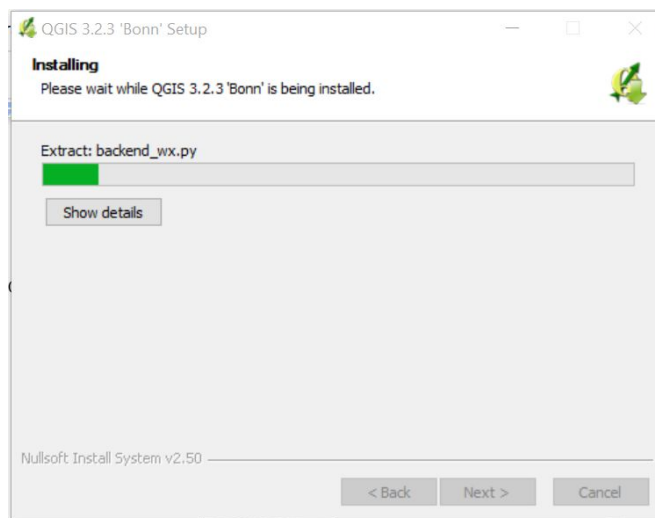

➔ Click 'Next' accepting the destination folder

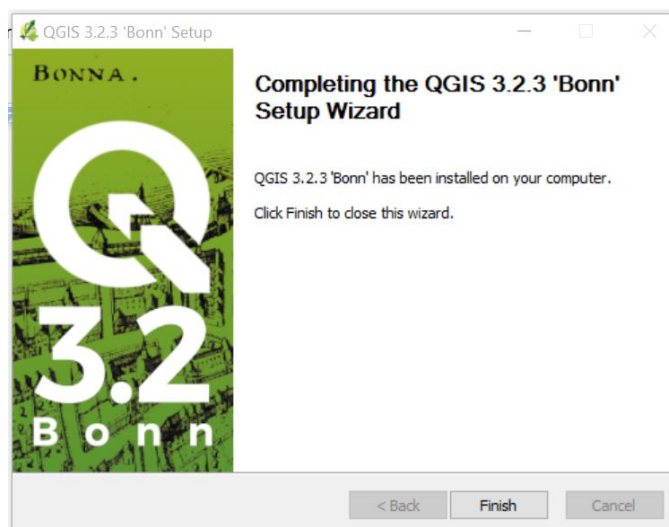➔ Click 'Install' on the 'Choose components' window.

We do not need to install any of the additional components offered, so no need to select any of them.

QGIS can take many minutes to install after this step.


➔ click 'Finish' when prompted.

We have provided you with the installation files to facilitate the smooth running of this course. These files are freely available to download directly from the QGIS website. Go to:

, or search on google for "qgis download" to find the webpage.

The download page currently looks as below, with different options listed, expandable using the arrows on the right hand side.
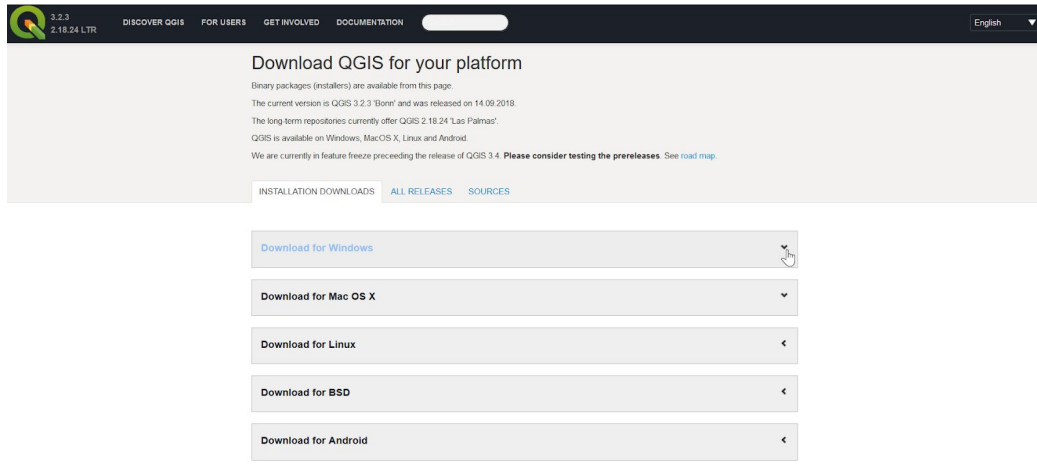
The download for Windows option currently offers the four options below. We will be using version 3.2 (64/32 bit depends on your computer as explained above).
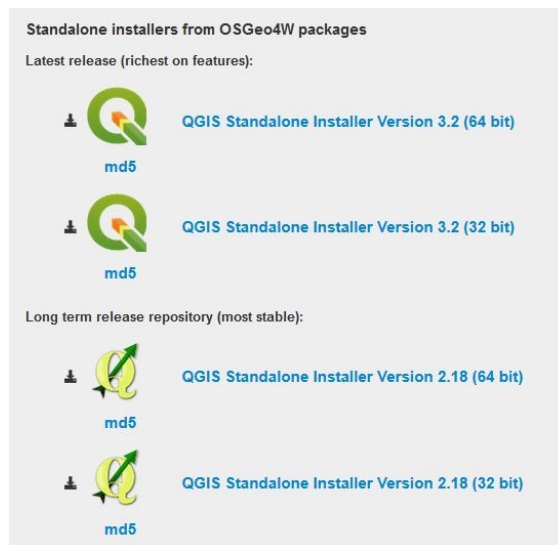
Macintosh

To install on Mac OS X follow the instructions from here: http://drjill.net/install-qgis-on-a-mac-in-8-steps/

The instructions are in English, ask us and we can help you follow the 8 steps. It requires a single download from here: http://www.kyngchaos.com/software/qgis. We have included the Mac installation file on the USB drive (software\QGIS-3.2.3-1.dmg).

Version 3 of QGIS requires operating system Yosemite (10.10) or higher. Version 2 can run on Mountain Lion (10.8) and newer.

Terminology and concepts

GIS - Geographical Information System

A GIS is a computer-based system for capturing, storing, visualising and analysing data that is associated with a geographical location on the Earth's surface.

For example, GIS software can be used to create maps and display data about diseases and disease control. This could be the location of cases, indicators about disease vectors such as mosquitoes, or information on other associated factors like temperature, vegetation, and water bodies. These maps can then be examined and analysed to identify spatial patterns in disease risk. Any patterns found can then be used to inform decisions about disease control activities.

Spatial data

This is the geographical information put into a GIS. Simply put, it is data that identifies a location on Earth. It is data that can be mapped, usually stored as coordinates. Spatial data can be divided into two categories: vector and raster.

Vector

The word 'vector' is rooted in the latin 'vehere' (to carry/convey). Its meaning today differs slightly depending on the context. In public health we talk about disease vectors, for example, mosquitoes carry and convey diseases such as malaria. The meaning in GIS is more in line with maths, navigation and images, where vector conveys direction, size and paths. In GIS, vector data represent locations in geographical space in the form of points, lines and polygons. An example of points could be the locations of households surveyed, lines could be roads or rivers, and polygons are closed shapes such as district boundaries or a lakes. Vector data are often stored as a 'shapefile'.

Shapefile

This is a file format commonly used to store vector data. One 'shapefile' is actually made up of multiple files (at least three, but often more), with the same name but different file extensions (such as .shp, .shx, .dbf, .prj, .cpg, .qpj). Each file contains different elements of the data - it's location and other associated information. All of these files must be saved in the same location in your computer.

Raster

These spatial data are stored as a continuous grid of pixels, with a value ('single band' raster) or values ('multiband' raster) associated with each pixel. Think of a photograph, if you zoom in or enlarge the image you can eventually see the pixels that make up the picture. We can also think about spatial resolution as similar to the resolution of a photo. How big are the pixels that make up the image, and what area does each pixel represent? Often raster data represent information captured by satellites or drones ('remote sensing' data). If you are familiar with Google Earth for example, this is raster data, obtained from satellites. Raster data are stored as an image file with associated geographical information. For example, this could be a TIFF file (.tif) together with a second file of the same name but different file extension (.tif.aux).
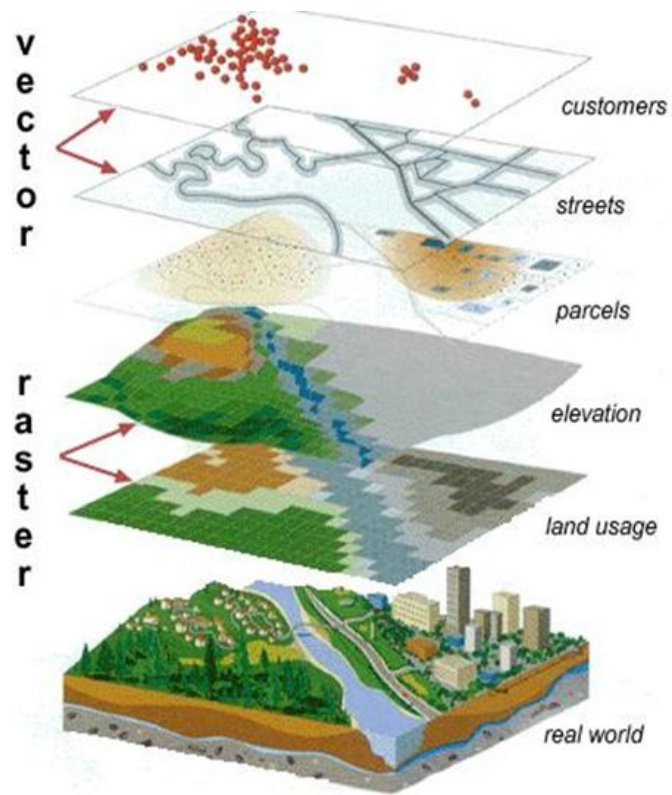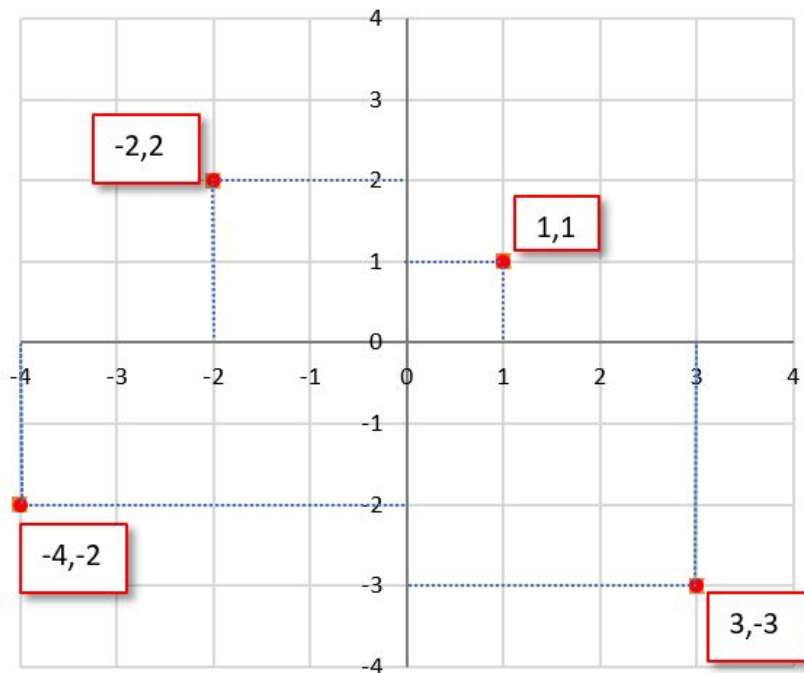
A visual representation of vector and raster data.

Coordinate reference systems

Essentially, what coordinate systems do is use numbers to describe the location of a position. If we think of plotting points on a graph, this involves using a basic coordinate system.

Geographic coordinate systems apply the same principle to the Earth, by fitting a grid that can be referenced with numbers onto the globe to give us the means of identifying and communicating locations around the world.

A common geographic coordinate system you may be familiar with is latitude and longitude. Lines of latitude and longitude were developed to form a grid of coordinates over the Earth's surface.
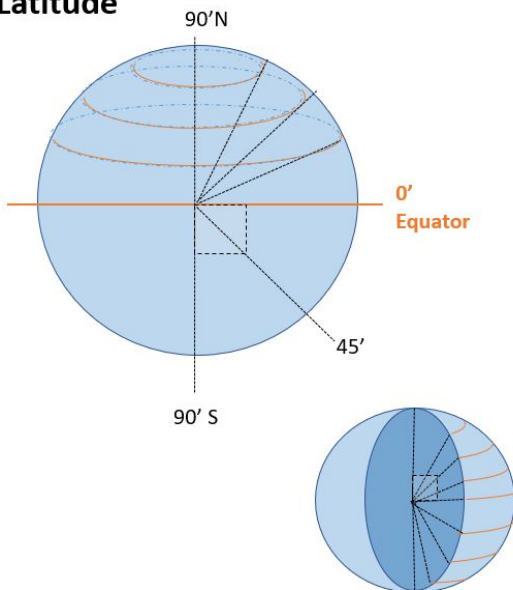
Latitude

A line was drawn around the equator, this is 0° latitude. Lines running parallel to this towards either pole were then added. The numbers associated with these lines denote the angle formed between their position, the centre of the earth, and the equatorial plane. For example, the poles are at 90°, north and south of the equator designated by a + or - number respectively or an N or S. Latitude is the equivalent of the y axis on a graph.
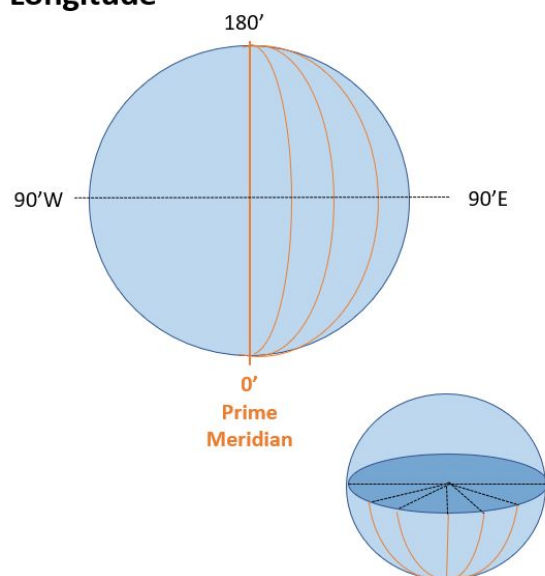
Longitude

Lines of longitude then run between the north and south poles. The 0° line of longitude is known as the prime meridian, it divides east from west. Where it should be placed was less obvious than for the equator, but it runs through Greenwich, England. Again, further parallel lines are drawn, with numbering based on angles this time ranging from -180° to +180°, West to East. Longitude is the equivalent of the x axis on a graph.


Coordinate format

Degrees of longitude and latitude can be be expressed in different formats, for example decimal degrees (xx.xxxxxx), degrees, minutes and seconds (xx° xx' xx''), and degrees, decimal minutes (xx°xx.xxxx'). The following examples represent the same location:

Decimal degrees	21.75555
Degrees, minutes, seconds	21° 45' 20''
Degrees, decimal minutes	21° 45.333'

Datum

The Earth is a 3D object, so when specifying locations the 3rd dimension -elevation- should be taken into account. The Earth is not a perfect sphere, it is more ellipsoid with an uneven surface. Briefly, the datum is about how the grid of coordinates fits onto the Earth. There are slightly different reference ellipsoids, and how the grid is centred can also change. There are datums designed to fit well on a smaller, local scale, and others which try to provide the best fit for the whole world and provide a globally comparable system.

An example of a commonly used datum is WGS 84. This stands for World Geodetic System 1984. GPS (Global Positioning Systems) use this datum.
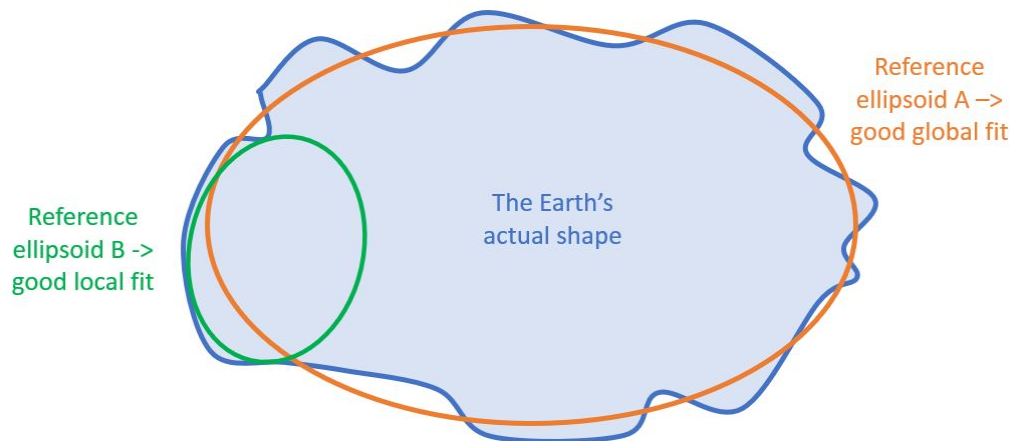
Projected coordinate systems. Another consideration of the earth being 3-dimensional is that it is not always convenient to work with a 3D globe, as opposed to say a 2D paper map. Projections were developed as a way of making this conversion. The image of the world is distorted when projected. Different projections exist to conserve different different aspects of the map.

A coordinate reference system should include details of the datum and any projection used.

Projection

Projections convert the 3D globe to a 2D map. These projections allow us to work with paper maps or a 2D image on a screen. This transformation can be done in different ways, but all involve compromises to things such as surface area, distance, and angular properties. Which projection you use therefore depends on how and what you intend to use your map for.

For example, angles can be important for navigation, especially historically for ships before the use of satellites etc., if performing measurements then conserving distance and having a comprehensible

unit may be more important, and our understanding of the size of different countries and continents can be hugely distorted by the projection of the earth we are accustomed to seeing.

Compare the two projections below, to the left is the Mercator projection, to the right the Gall-Peters. Note the different sizes of Africa and Greenland. The Gall-Peters projection on the right more accurately reflects land surface area.

(Left) the Mercator projection, (Right) the Gall-Peters projection

Opening and navigating QGIS

We are going to start exploring QGIS. To do this, we are going to look at a project we have provided for you.

There are different ways of opening QGIS.

- Selecting and opening a QGIS project file will open QGIS automatically.

➔ In your folder QGIS_training, go to materials, and look for a file called "day1"⌐
➔ Double click on the day1.qgz file to open it.
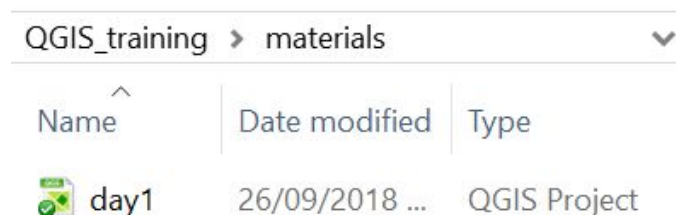
- Alternatively, QGIS can be found and opened from the list of applications in your computer, under Q. We are going to use the 'Desktop' app.

➔ Click on the Windows symbol
➔ All apps
➔ Scroll to Q
➔ Expand the folder QGIS 3.2
➔ Select "QGIS Desktop 3.2.3" from the list.
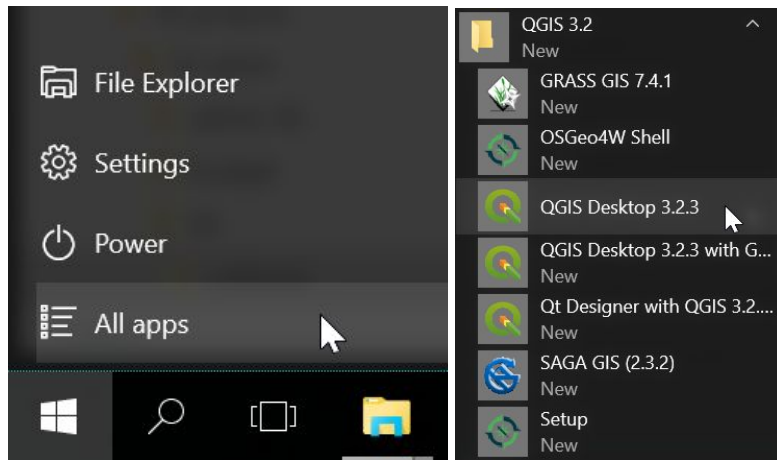
Whichever way you open it, QGIS may take a while to start, during which time it will display this window :
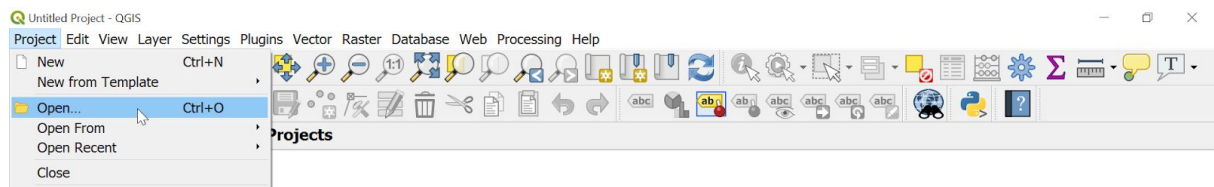

If opening QGIS for the first time it will look something like this:
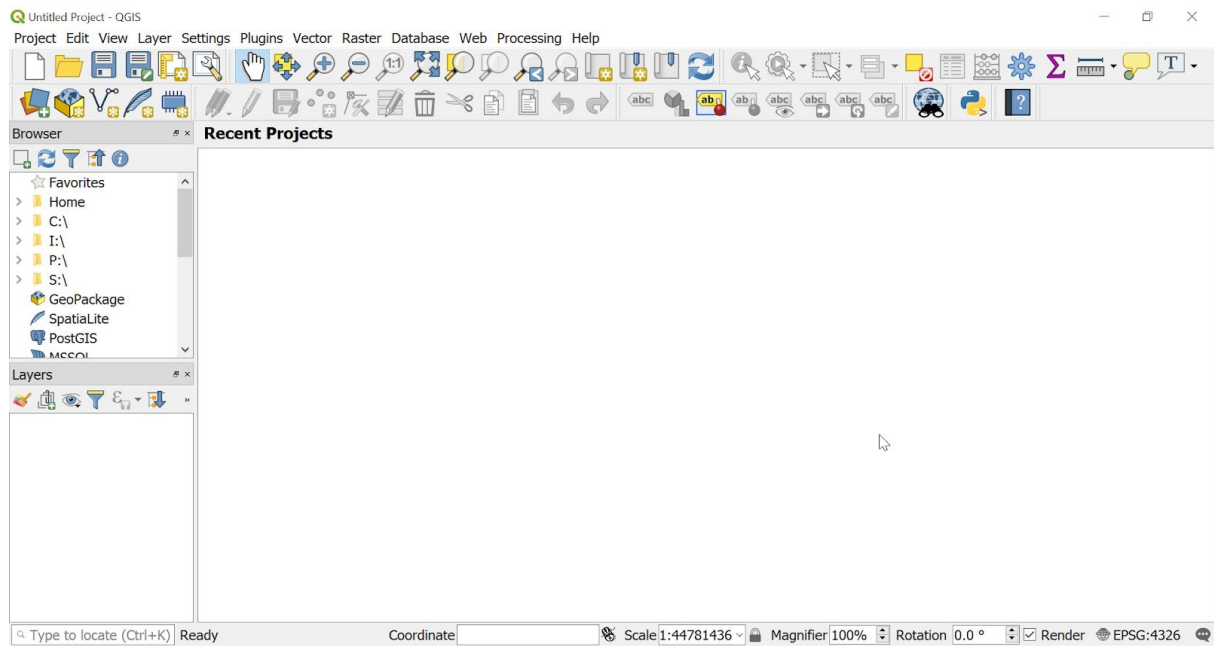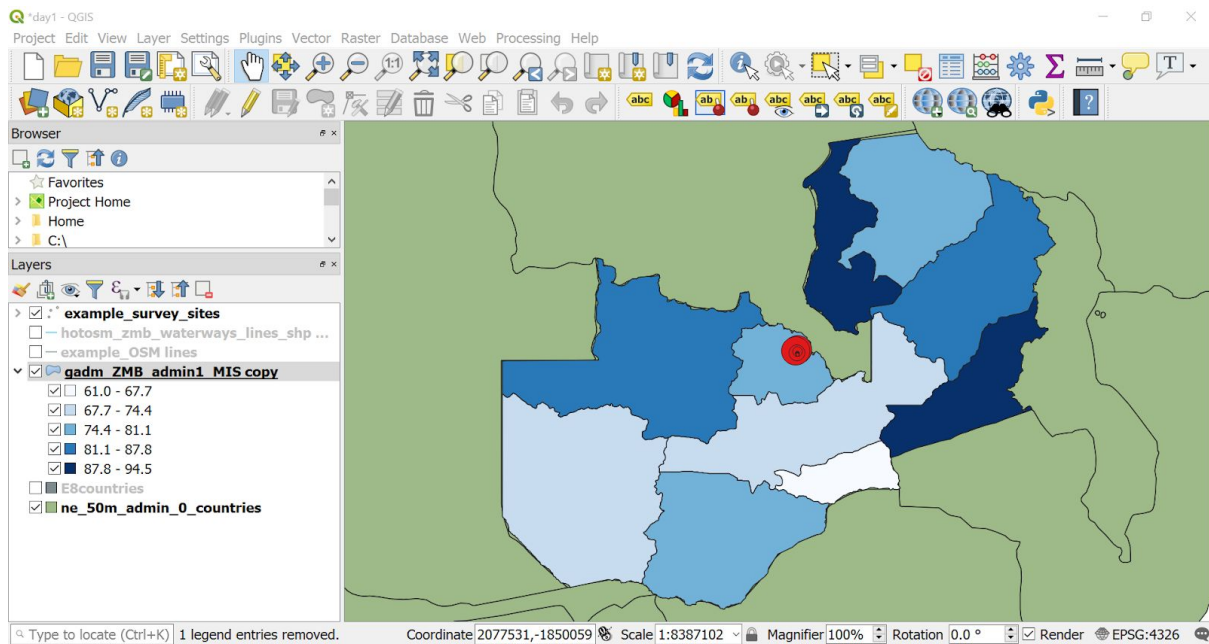
Note that there is a "Recent Projects" window, which will offer shortcuts once you have projects to return to.

Otherwise, projects can be accessed via the menu bar by selecting
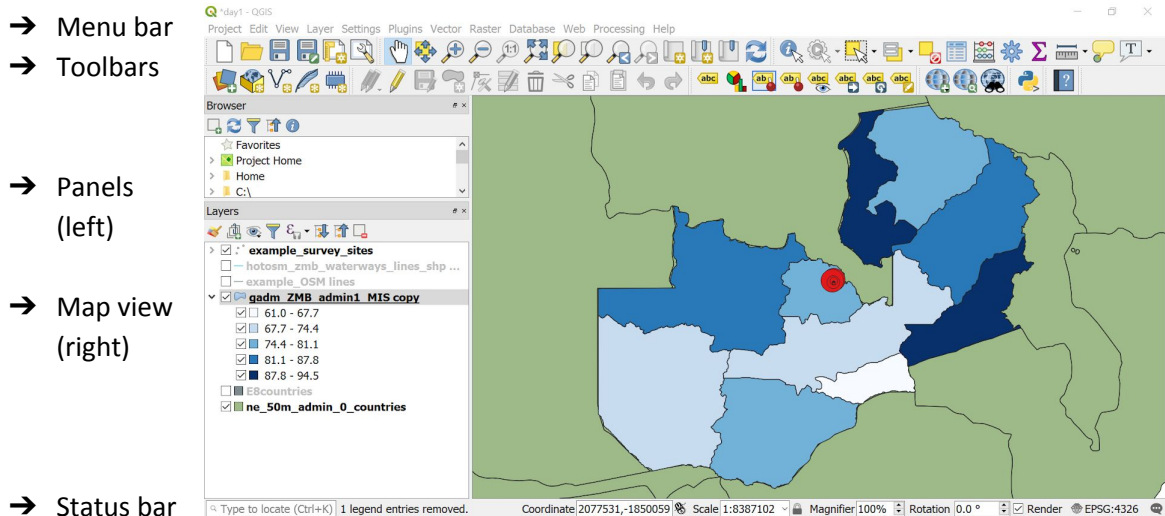
➜ Project
➜ Open
➜ Browse and select your project file.

When the QGIS project opens it should look something like this :

Here the different areas of the QGIS User Interface are labelled :

➔ Menu bar
➔ Toolbars

➔ Panels
(left)

➔ Map view
(right)

➔ Status bar

Menu bar: Project, Save as

The menu bar, as with many programmes, is one way of accessing different system functionality. Clicking on menu titles will show an expanded list of options under that heading, which can also be selected by clicking with your mouse.

We will use the 'Project' option as an example. A project in QGIS is the collection of all the 'layers' you add, and the way in which you have styled them. It is often good practice before you start editing something to work on a copy to preserve the original. To do this, we can use the 'Save as' option, similar to with other software.

➔ Go to 'Project' on the far left hand side of the menu bar.
➔ Select 'Save as'
➔ Browse in the folder 'QGIS_training' for 'my_work'

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➔ Give your project a name (for example my_day1).
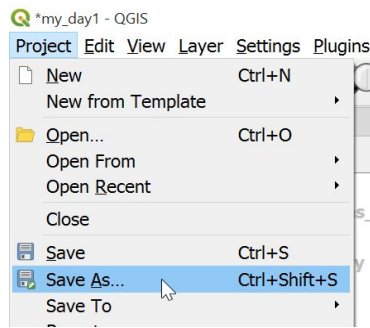
Toolbars

Toolbars exist to provide shortcuts to functions you use frequently. They can save you the time of going through multiple clicks and steps to access the same feature through the menu, for example note the 'Save As' icon we accessed through the menu is also available in a toolbar.

For icons you are less familiar with, there are some hints configured in the system. If you pause the cursor and 'hover' over buttons in the toolbars a little message will appear telling you what that button does, as below for 'Zoom In'.
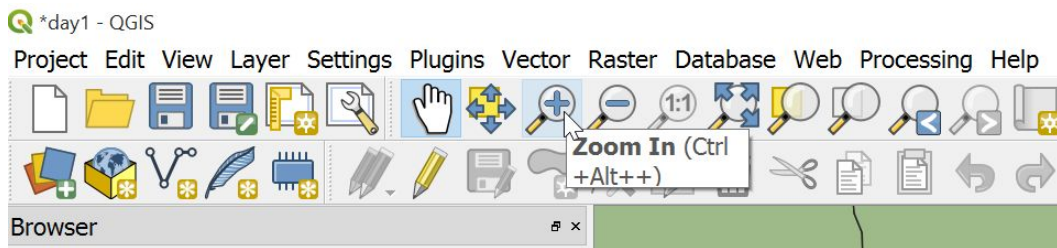
➔ Try 'hovering' over some of the buttons yourself. The hover message disappears after a while.
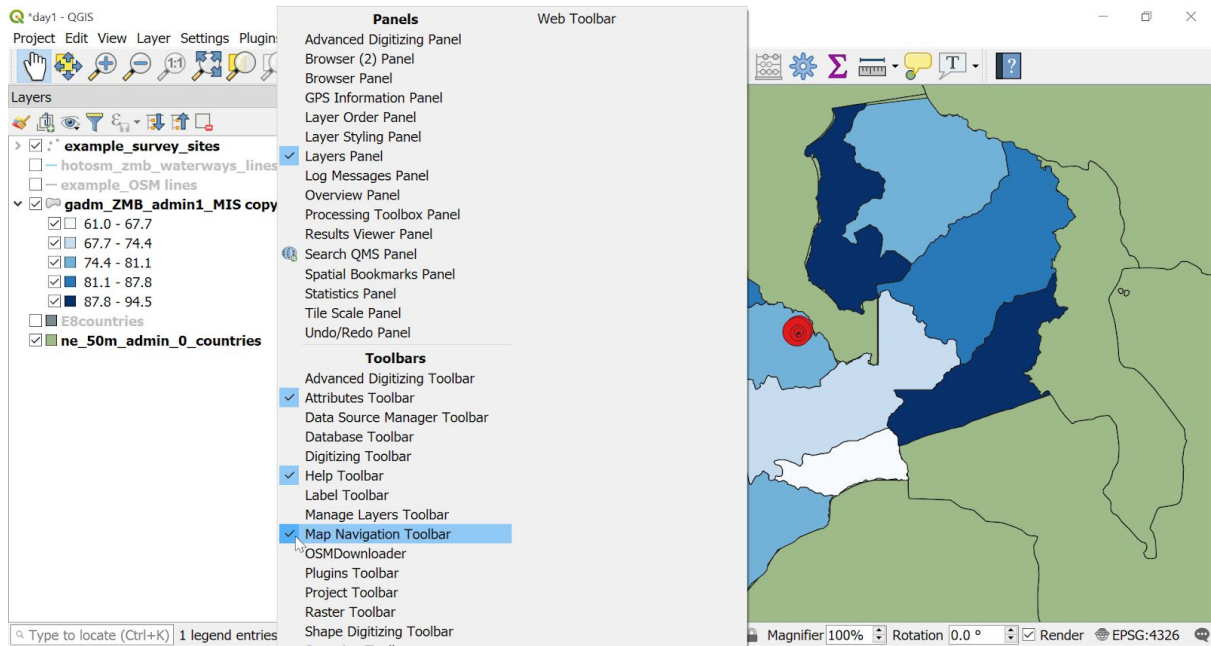
Panels

Panels are small windows we can display which allow us to actively manage system functionality. There are many panels available, when you first install and open QGIS you will typically see two: Browser and Layers. The layers panel can be very useful for working on how your map is displayed, more detail on this will follow.

Toolbar and Panel visibility

QGIS is a powerful piece of software with many toolbars and panels available. As we are unlikely to want to use them all at once, we have the option to choose which are displayed at any time. Initially we will only be using a small number of these, so we will deselect others to simplify our screen and maximise space.

➔ Right click in Panels or Toolbars to display a list of available options for both.
➔ Uncheck options until you are left with the 4 shown below (Layers Panel, Attributes Toolbar, Help Toolbar, Map Navigation Toolbar)
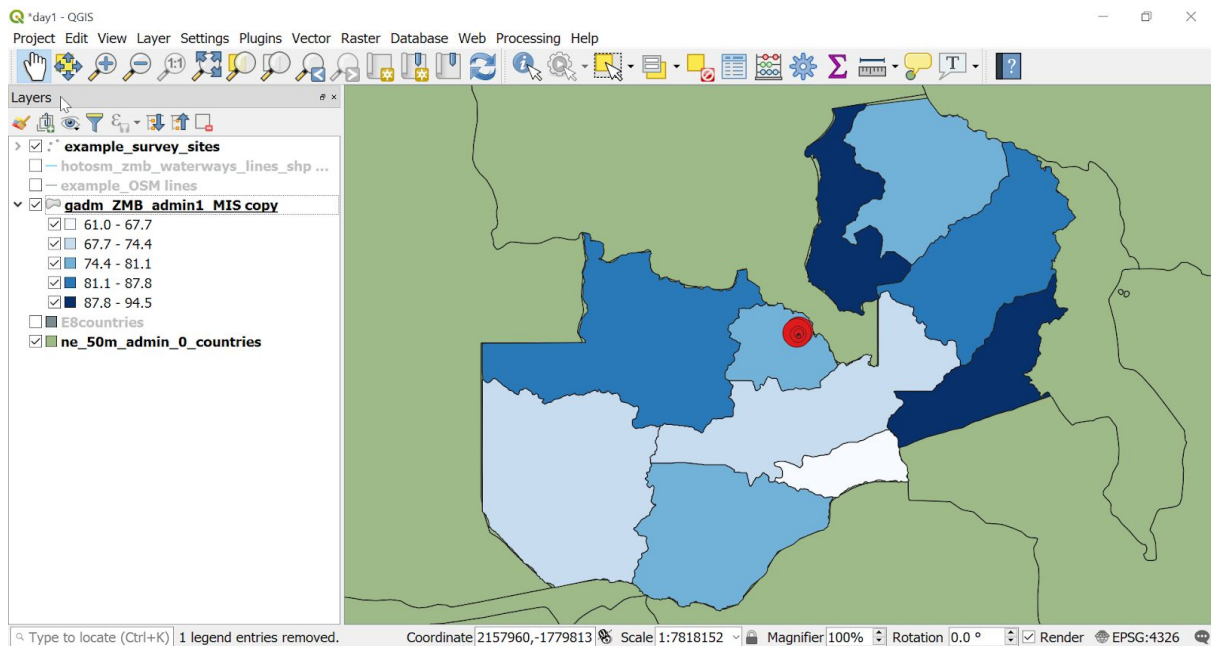
You can return to this menu at any time if displaying additional tools or panels would be useful, or if you accidentally close something.
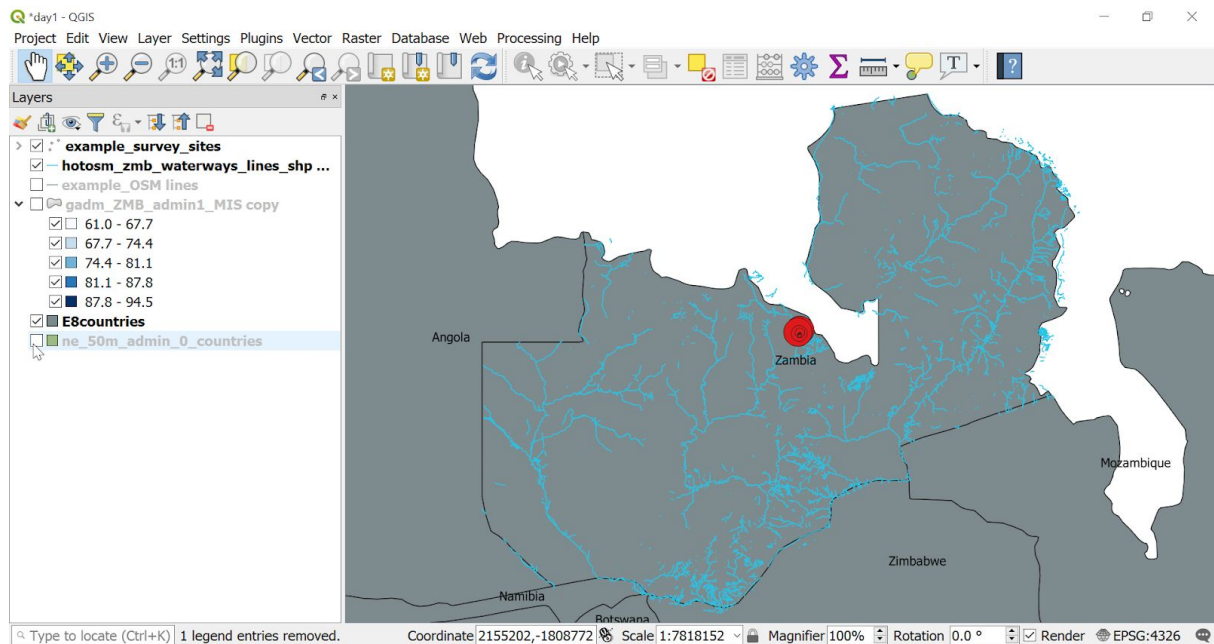
Layers panel

Data are displayed in the map as 'layers' that appear in the Layers Panel on the left. We will be using the Layers Panel a lot.

The checkboxes to the left of each layer name within the Layers Panel allow you to change what is displayed in the map view.

➔ Experiment with unchecking boxes and see how features no longer appear in the map view. Checking the box again makes them come back (they have not been deleted they are just not shown when they are unchecked).

The order of layers in the Layer Panel determines how they appear in the map view. The layers at the top are displayed last and those at the bottom are displayed first. It is like the higher up layers are painted on top of the lower layers. This can mean that some layers get hidden by others. You can change the order of layers by clicking and dragging them within the Layers Panel. It is also possible to make layers partially transparent to allow us to see those underneath.

➔ In the Layers Panel, tick the box to select the layer 'ne_50m_admin_0_countries'
➔ Left click, hold and drag this layer so that it is on top of the layer 'E8countries'
➔ Release the mouse button when you are in position

This is a little tricky, you need to let go of the mouse button in a certain place and if you don't the layer will not move. Try experimenting.
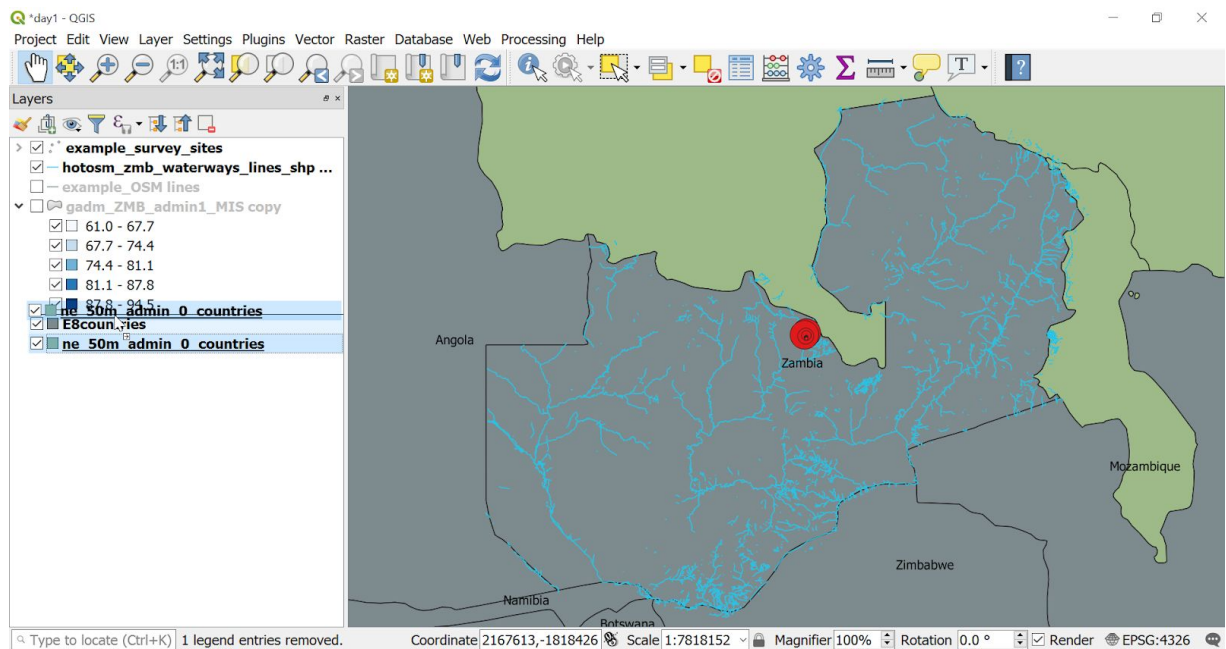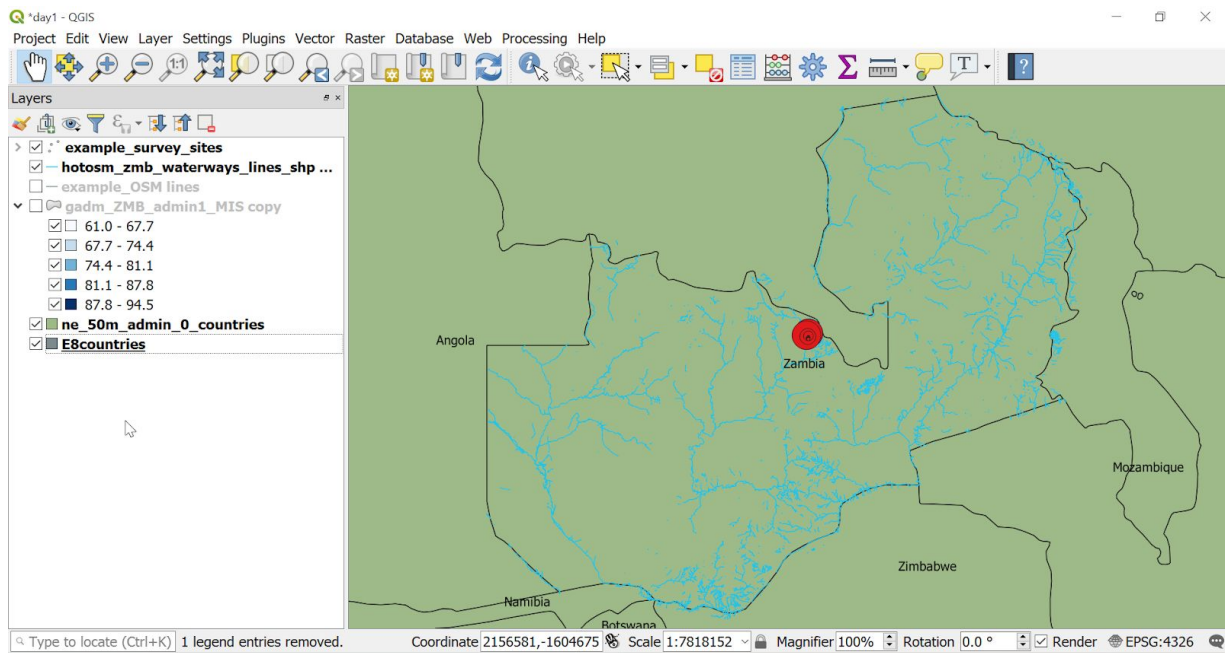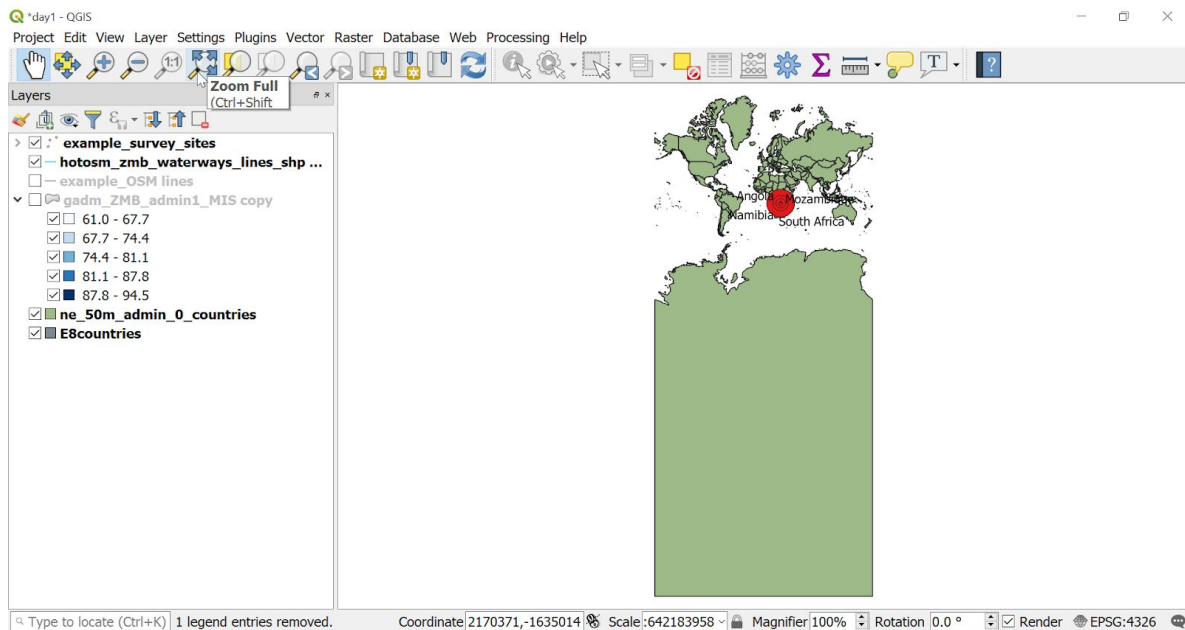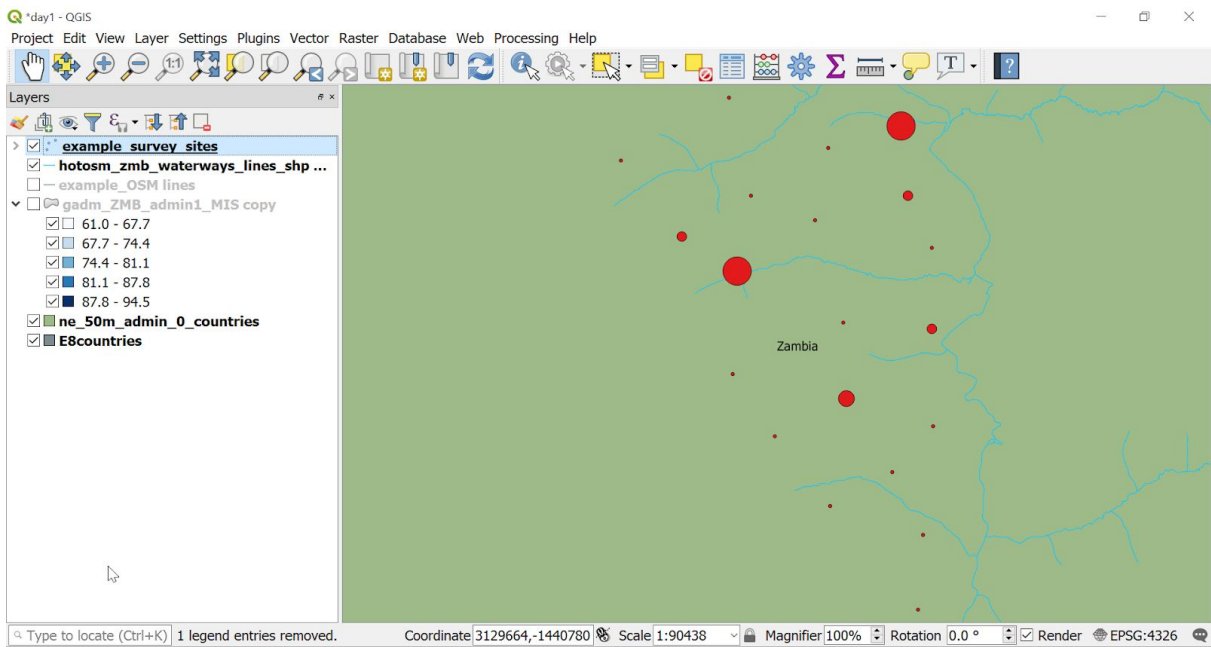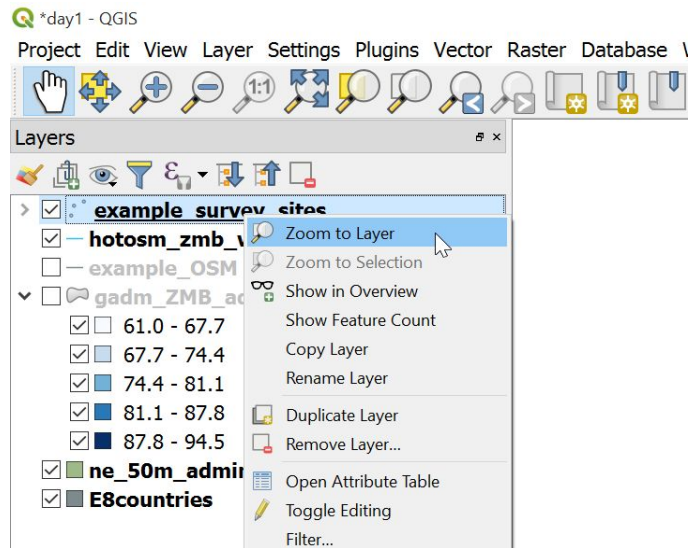
Zoom and Pan options

There are many ways to change the position and size of the area that is shown within the map view. Have a try.

➔ Use the zoom buttons from the toolbar. For example: Zoom Full.
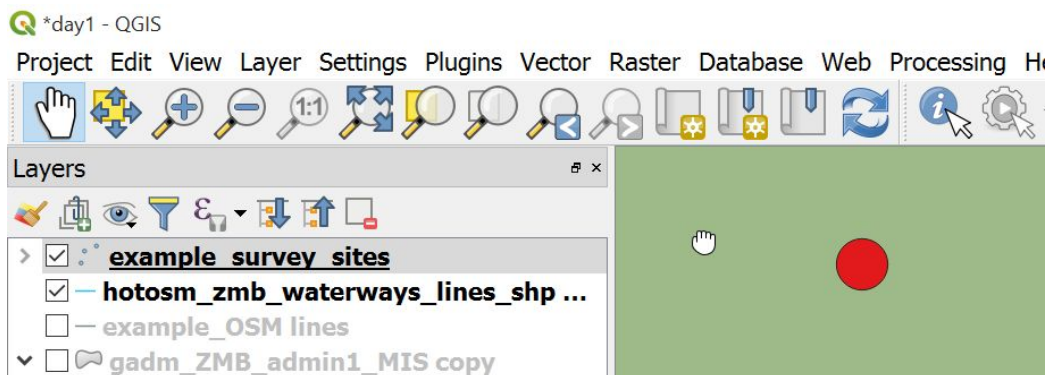

➔ Right-click on a layer in the layers panel and use the 'Zoom to Layer' option. Try and zoom to 'example_survey_sites'.

→ Zoom in and out with the mouse wheel (if you have one).

→ With the Pan icon selected (hand symbol), left click in the map view and drag to move the map.
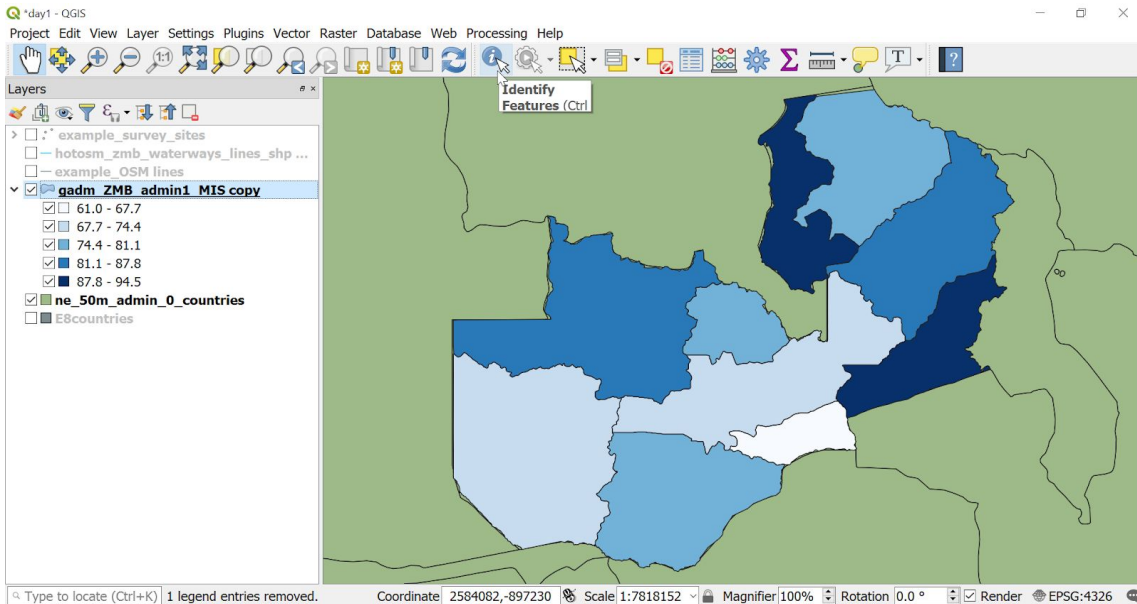
Identify features

There are many ways to find out information about the map. One way is to use the 'Identify features' button to bring up information about map features stored in the currently selected layer :

➔ First, just to make things clear and bring us all back together:
  ◆ check/uncheck boxes so that you have two layers showing 'gadm_ZMB_admin1_MIS_copy' and 'ne_50m_admin_0_countries'.
  ◆ Zoom to layer on the gadm_ZMB... layer.
  ◆ Your screen should look something like below.

➔ Left click the 'gadm_ZMB…' layer in the Layers Panel to select it
➔ Left click the 'Identify Features' button in the toolbar ('i' in a blue circle with an arrow)
➔ Left click in one of the blue polygons on the map to select it. The selected feature will be highlighted.
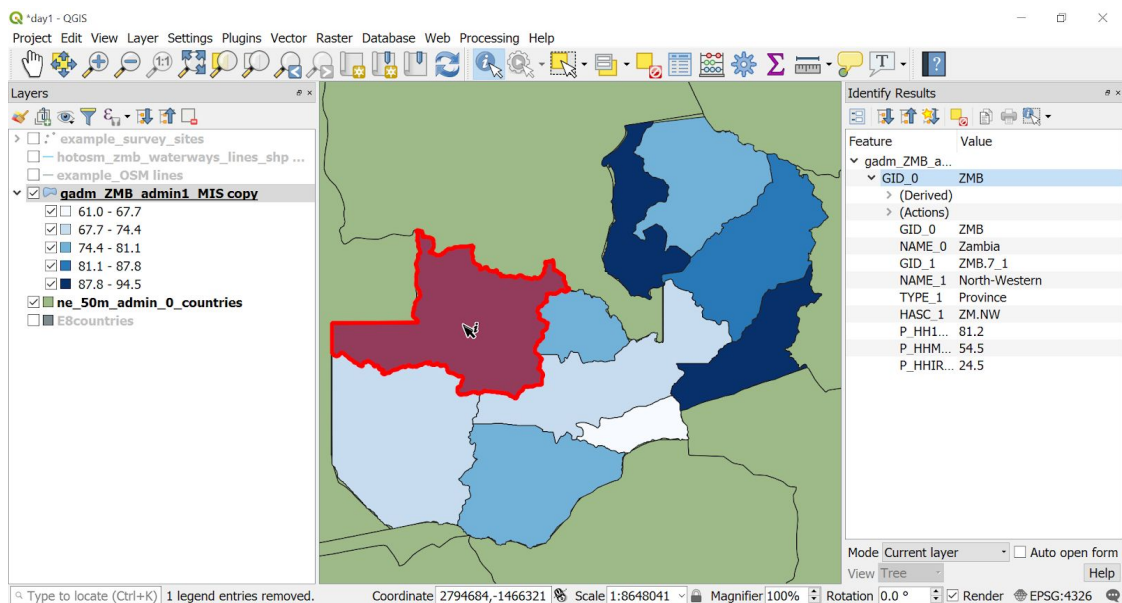
➔ This should also bring up a panel on the right where you should be able to see information about your selected feature, for example it's name and some figures in this case.

➔ To exit this mode, select the Pan tool (hand shape, far left of toolbar).

➔ Close the identify results panel by clicking the cross in the top-right-hand corner of the panel.

Attribute tables

The information about all the features of each layer is stored in tables, called 'Attribute tables'. These are like spreadsheets of data associated with the map layer.

Attribute Tables are very useful, to view one :

➔ Right click on a layer in Layers Panel

➔ select 'Open Attribute Table'
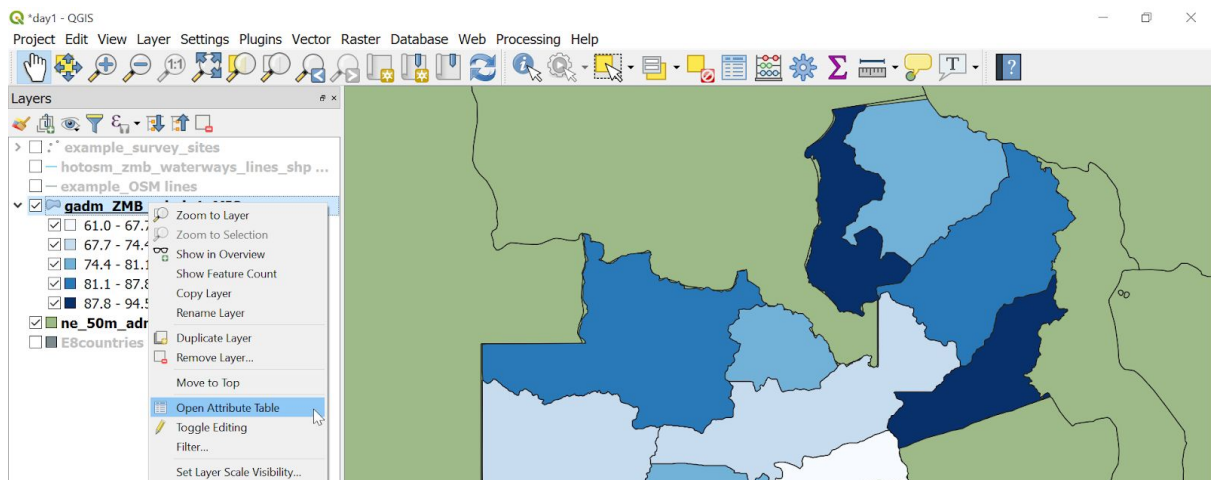
The attribute table for the 'gadm_ZMB...' layer should look like below. Each row stores data about one feature. In this example, a feature is a Province hence there is one row per Province. Have a look at the columns and values.

|	GID_0	NAME_0	GID_1	NAME_1	TYPE_1	HASC_1	P_HH1NET	P_HHMemSle	P_HHIRS12M
1	ZMB	Zambia	ZMB.1_1	Central	Province	ZM.CE	73.7	52.9	21.7
2	ZMB	Zambia	ZMB.2_1	Copperbelt	Province	ZM.CO	76.6	43.3	43.5
3	ZMB	Zambia	ZMB.3_1	Eastern	Province	ZM.EA	94.5	79.7	56.0
4	ZMB	Zambia	ZMB.4_1	Luapula	Province	ZM.LP	88.6	66.2	31.6
5	ZMB	Zambia	ZMB.5_1	Lusaka	Province	ZM.LS	61.0	41.8	17.4
6	ZMB	Zambia	ZMB.6_1	Muchinga	Province	ZM.MU	82.2	58.4	27.7
7	ZMB	Zambia	ZMB.8_1	Northern	Province	ZM.NO	78.9	49.9	17.5
8	ZMB	Zambia	ZMB.7_1	North-Western	Province	ZM.NW	81.2	54.5	24.5
9	ZMB	Zambia	ZMB.9_1	Southern	Province	ZM.SO	80.2	57.3	25.8
10	ZMB	Zambia	ZMB.10_1	Western	Province	ZM.WE	71.8	52.4	18.1

The column names should give some indication to the data that are held in them. Sometimes these will be standard names and codes, sometimes this will be your data. These are your variables that you will be exploring. We will talk more about how these get there in the modules on generating spatial data, and adding and joining data to QGIS.

- ➔ Close the attribute table by clicking the x in the top right corner.
- ➔ Have a look at another attribute table for another of the layers to see what data there is, the points for example.
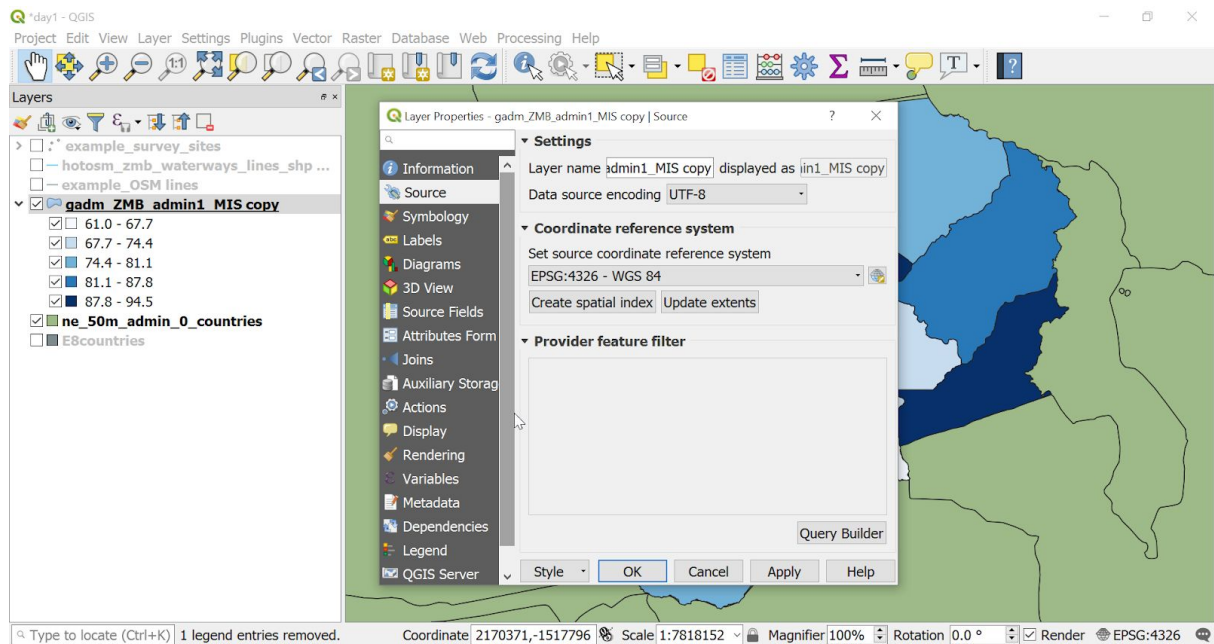
Layer properties

Another important way to view (and sometimes change) information about a layer is via the Layer Properties window. To access this window:

- ➔ Right click on the layer and select 'Properties'
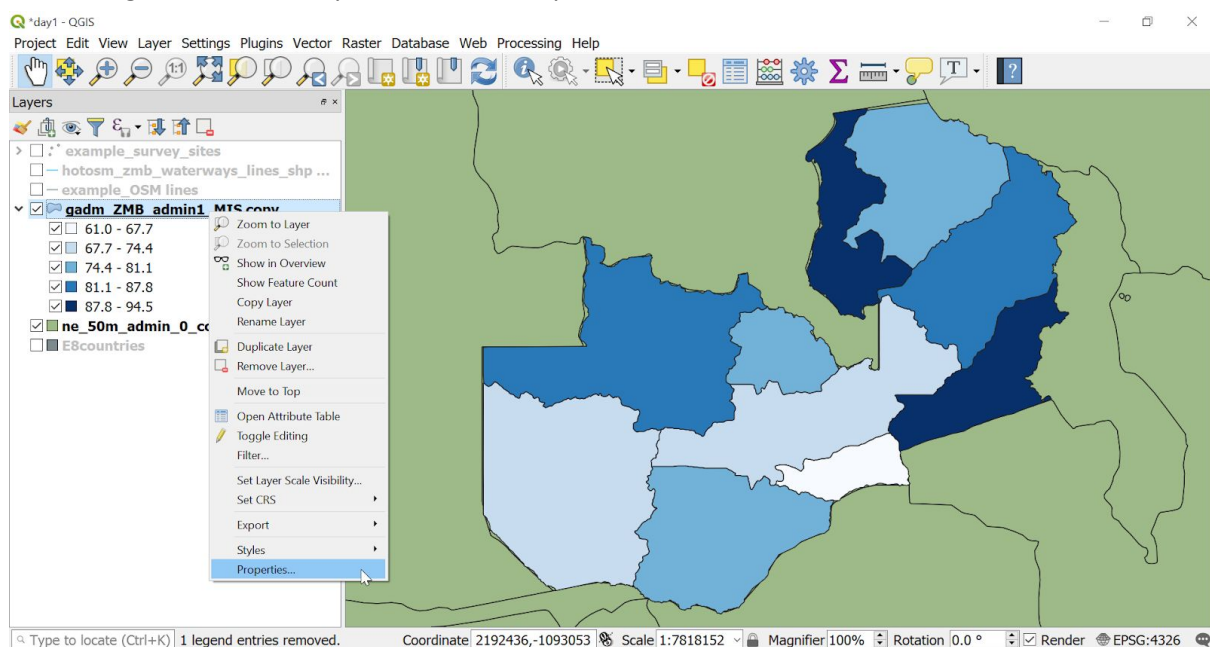
➔ Note that there are many options available listed down the left-hand side of the window, and connected with each of those are various other options.

➔ Close this window by via the cross in the top right corner, or the cancel button.

Layer properties is something you are likely to use quite a lot, we will return to this later.

Selection tools

In both the attribute table and the map view there are selection tools which will allow you to click-on one or multiple rows in the table or features of a map. Selecting them highlights them both in the map (in yellow) and in the table (in blue).
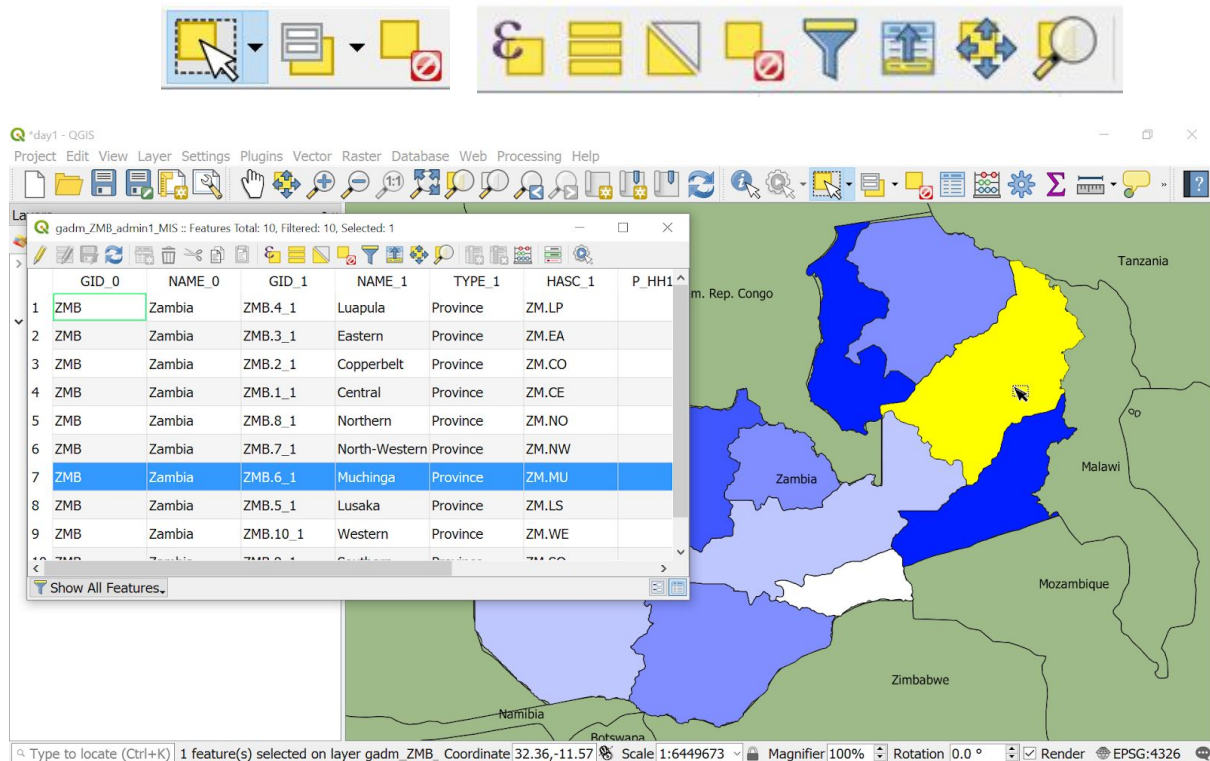
It is possible to save your selection and create a separate layer from only those items. It is also possible to do a selection by expression, which can allow you to pick out certain attributes.

→ To de-select everything, use this button:

→ To come out of selection mode, select a different tool, for example, Pan:

## Base maps and plugins

Base maps

Sometimes when starting to make a map we have no point of reference as to where we are in the world. For example, imagine some points on an otherwise blank map view, with no other information for context we don't know if these are in a city in England or a forest in Brazil. Adding a satellite or mapped image of the world as a base layer can help us begin to understand what we are looking at. There are 'plugins' available which can give us access to these kind of base maps. We will use one called '**QuickMapServices**'.
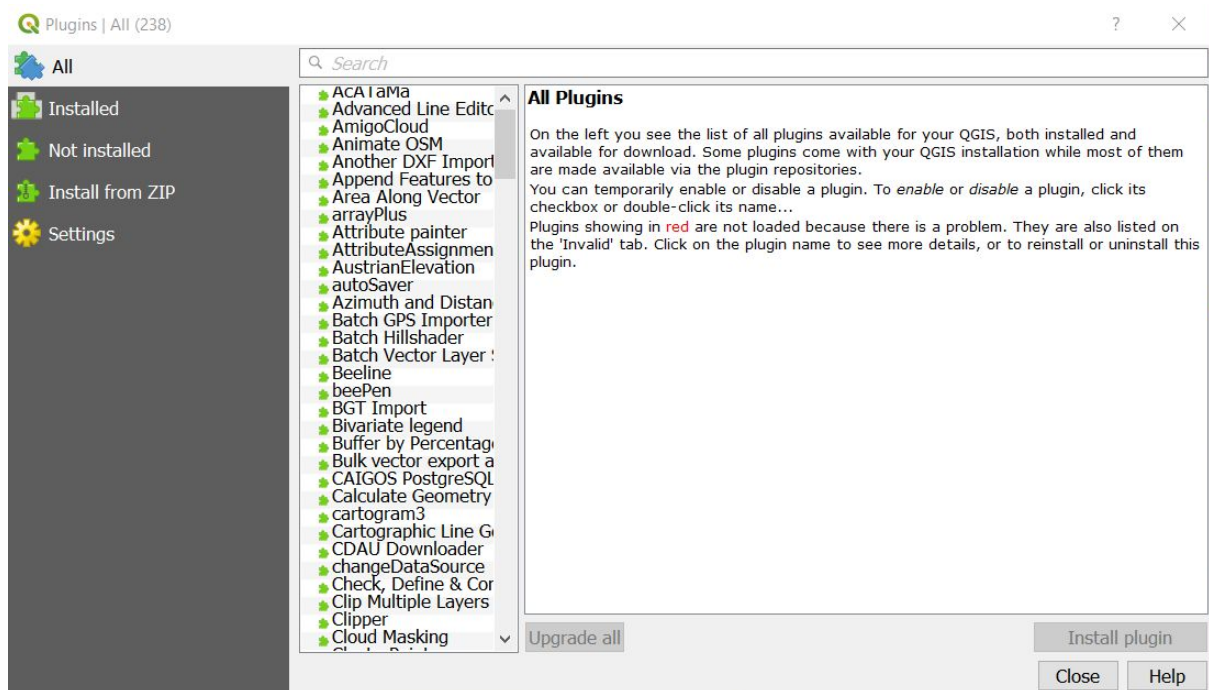
Plugins

Plugins are optional features and functions created by the developers of QGIS and other members of the GIS community. These are optional extras, and there are a long list of them available. If we identify a plugin that will be useful to us, it will need to be installed and activated. This will need a connection to the internet. You only need to install a particular plugin once it will then be available for you to use in future QGIS sessions without having to repeat this process each time.

To find and install a plugin:
- ➔ Left click on Plugins in the menu bar
- ➔ Select 'Manage and install plugins'
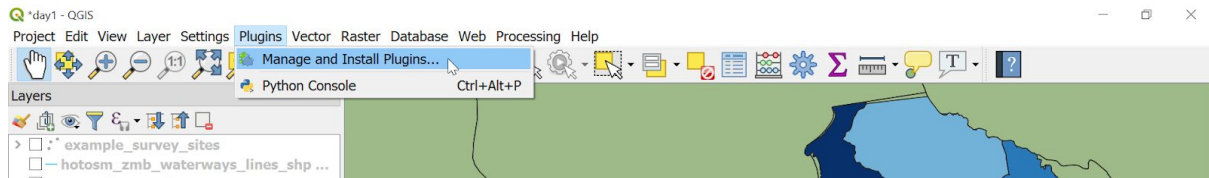
That should bring up this window :

- ➔ Check that 'All' is selected from the list on the left-hand side.

Note that window title indicates that I have 238 plugins available, this number may be slightly different for you. If it is much lower it could indicate that you are not connected to the internet and cannot access the online plugin library.

- ➔ To find a plugin from the list use the search box at the top, to narrow the selection.
- ➔ Type 'quickm' into the search box, which should bring the list down to a few
- ➔ Left click on '**QuickMapServices**' to select it.
- ➔ Click Install plugin
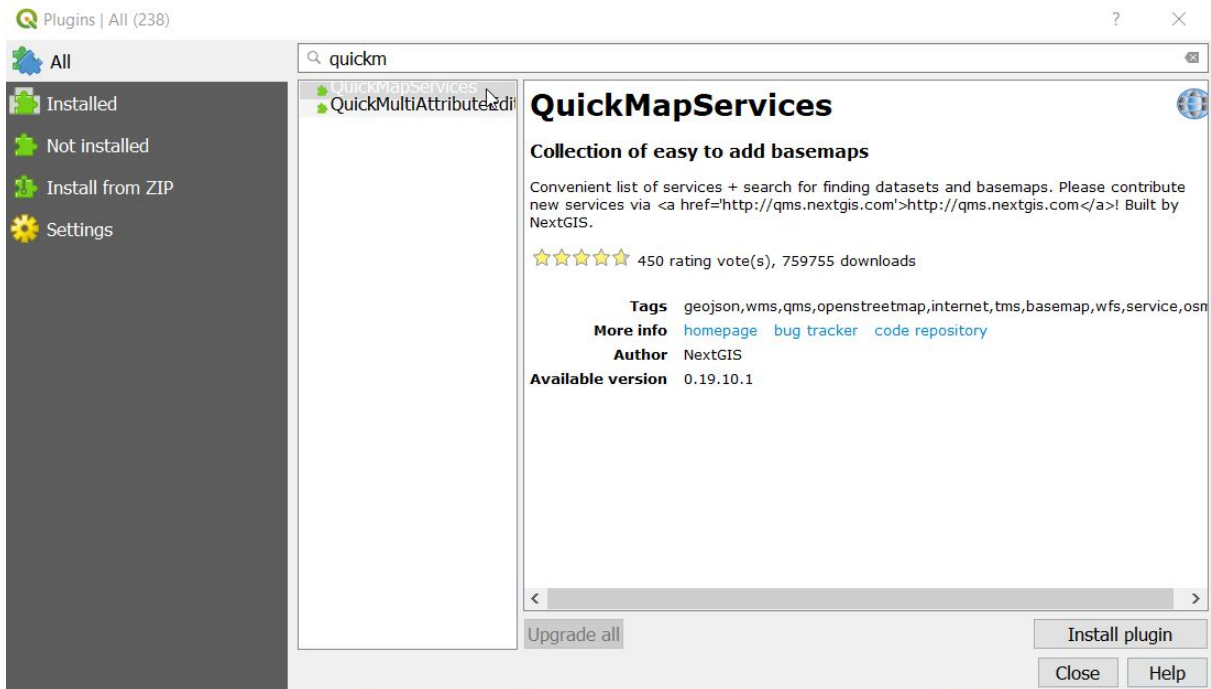
A pop up window should appear briefly, followed by a message that the plugin has installed successfully.

➔ Check that the small box next to 'QuickMapServices' in the list is ticked (if it is not, left-click to select it, this will ensure the plugin is active and available)
➔ Click Close to close the Plugins window.
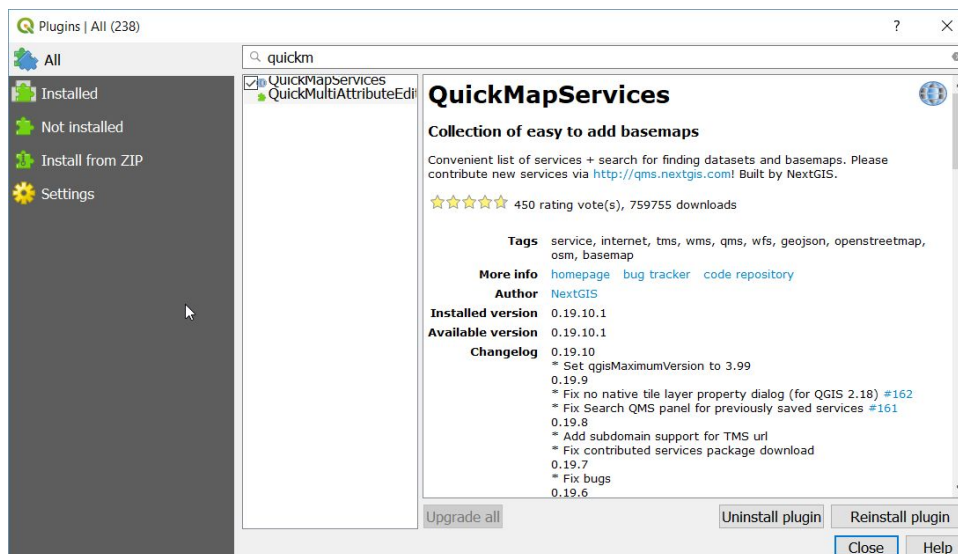
Once we have the QuickMapServices plugin installed, we can use it from 'Web' in the Menu bar :
➔ Click on Web in the menu bar
➔ Move your cursor down to QuickMapServices, this will offer you a number of base map options.
➔ Select OSM and then OSM Standard

OSM stands for OpenStreetMap which is an excellent free and open base map we will talk about more later.
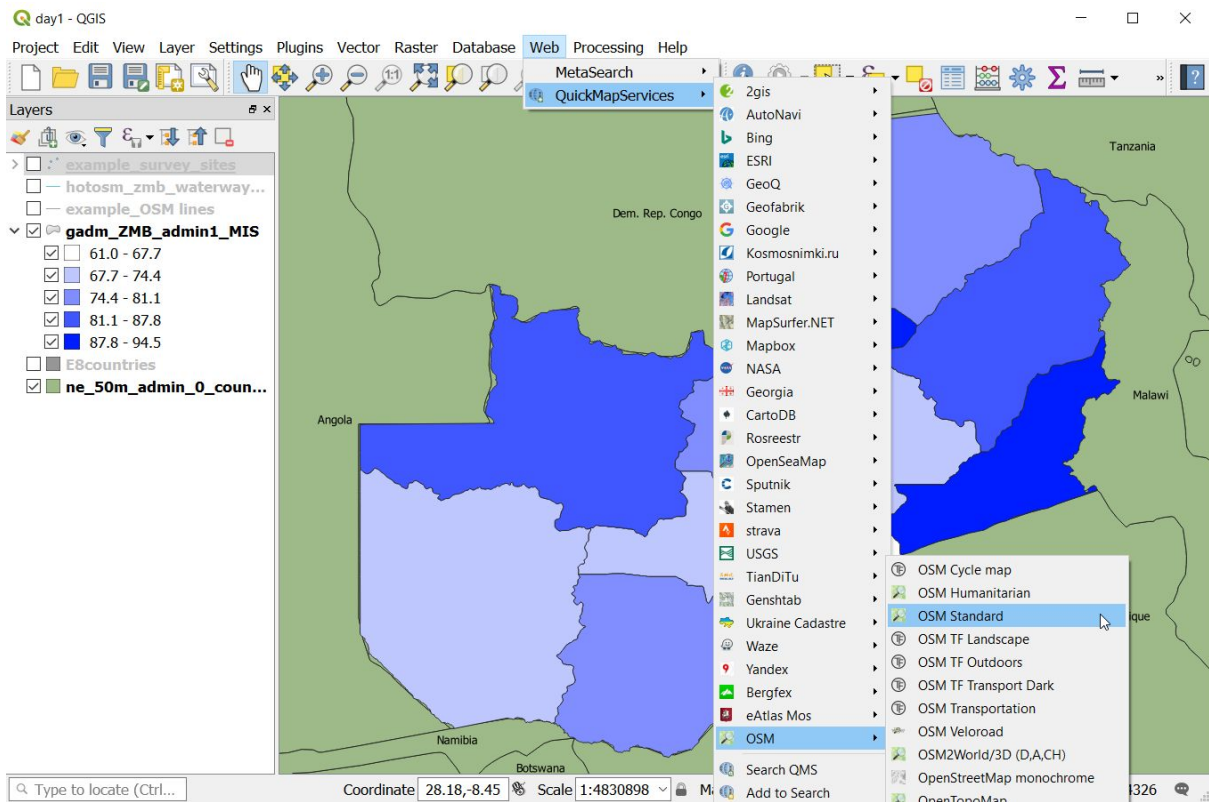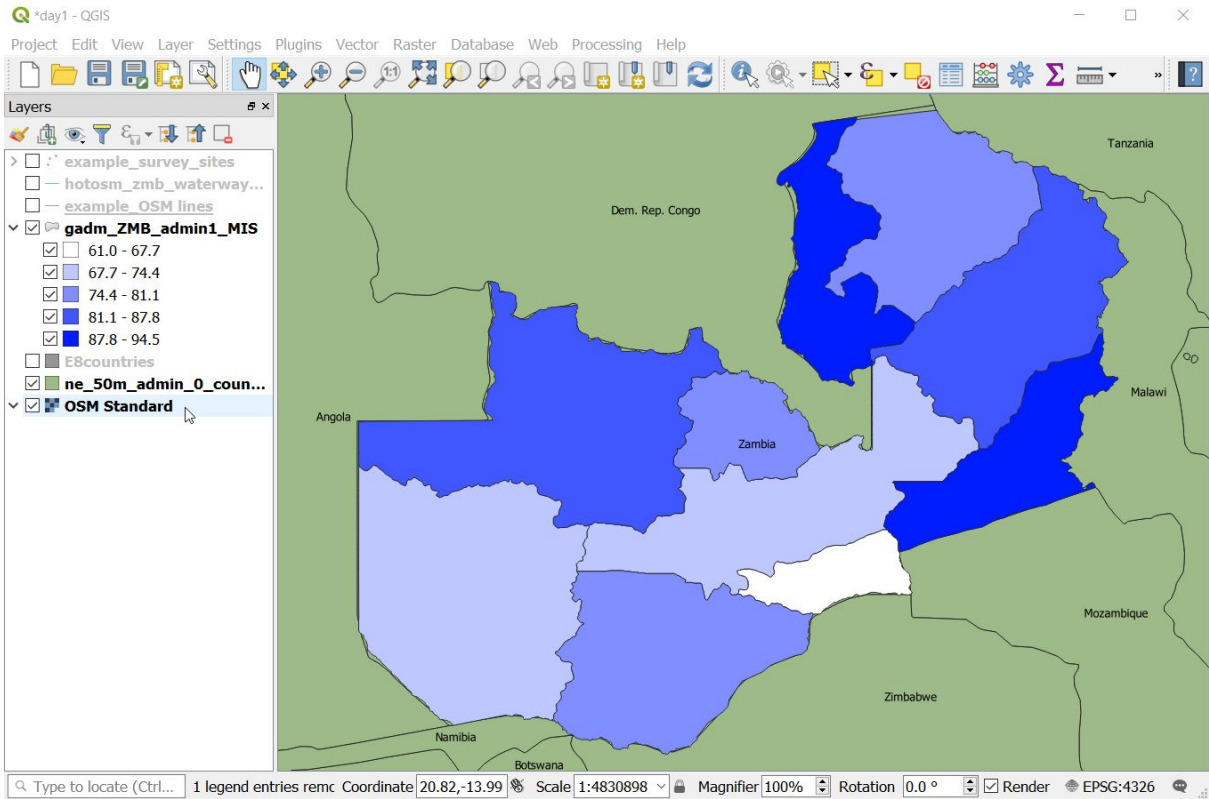

At first you may notice no changes to your map, but can see that 'OSM Standard' is indicated in the layers panel on the left as shown below.
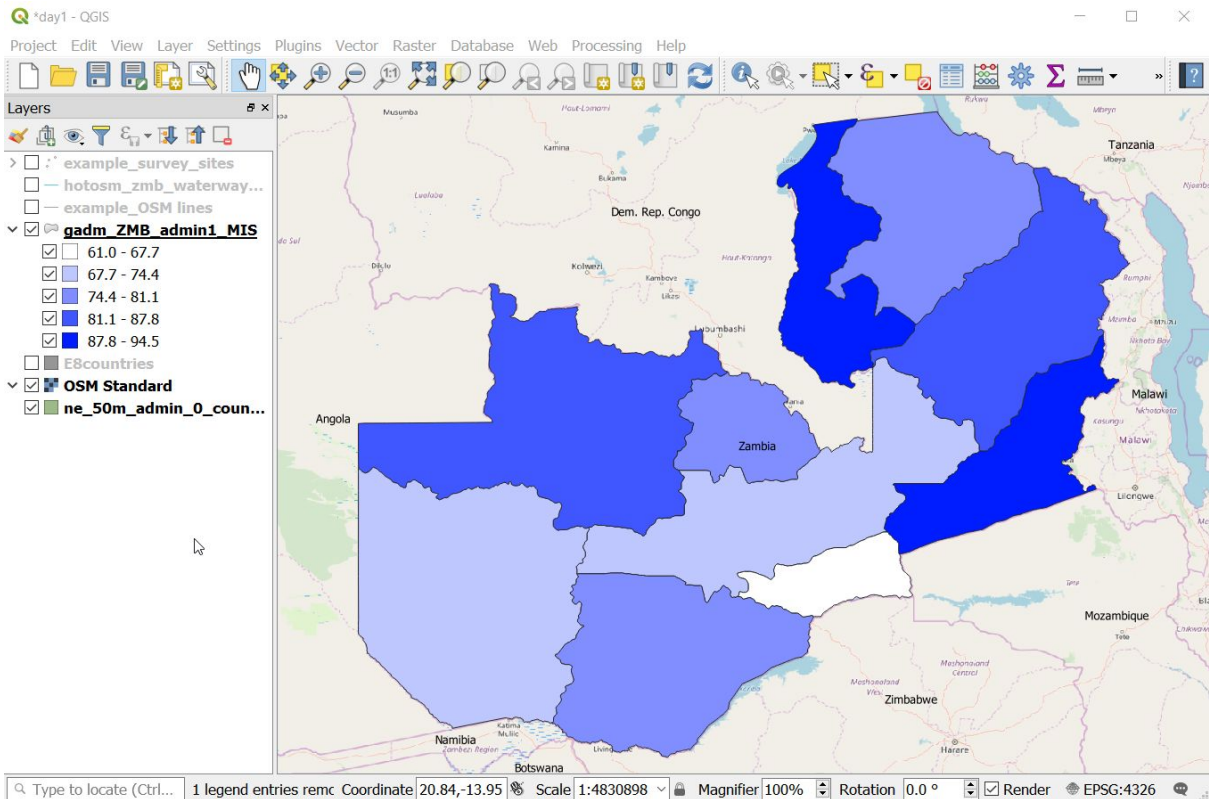
Question:

❖ Can you think why we can't see any change in the map ?
❖ Can you think of a way of being able to see the new basemap ?

Answer :

❖ The OpenStreetMap 'OSM Standard' layer was added to the bottom of the layers list.
❖ Try clicking and dragging the layer to above 'ne_50m_…'.
❖ You should then be able to see our data on top of the OpenStreetMap.

The OSM layer is an image or raster layer. It is loading from the internet. It is possible to zoom in and out, to see individual buildings or the whole world. The detail that is shown changes according to your zoom level. When you are zoomed in it shows lots of detail when you are zoomed out it shows very little. How quickly the map loads will be dependant on your internet connection.

➔ For this reason, if you are not actively using the base map, it is a good idea to deselect it, by unchecking the box in the layers panel.

Try zooming in to an area in Democratic Republic of the Congo to see by clicking and dragging a small box after selecting the zoom button.
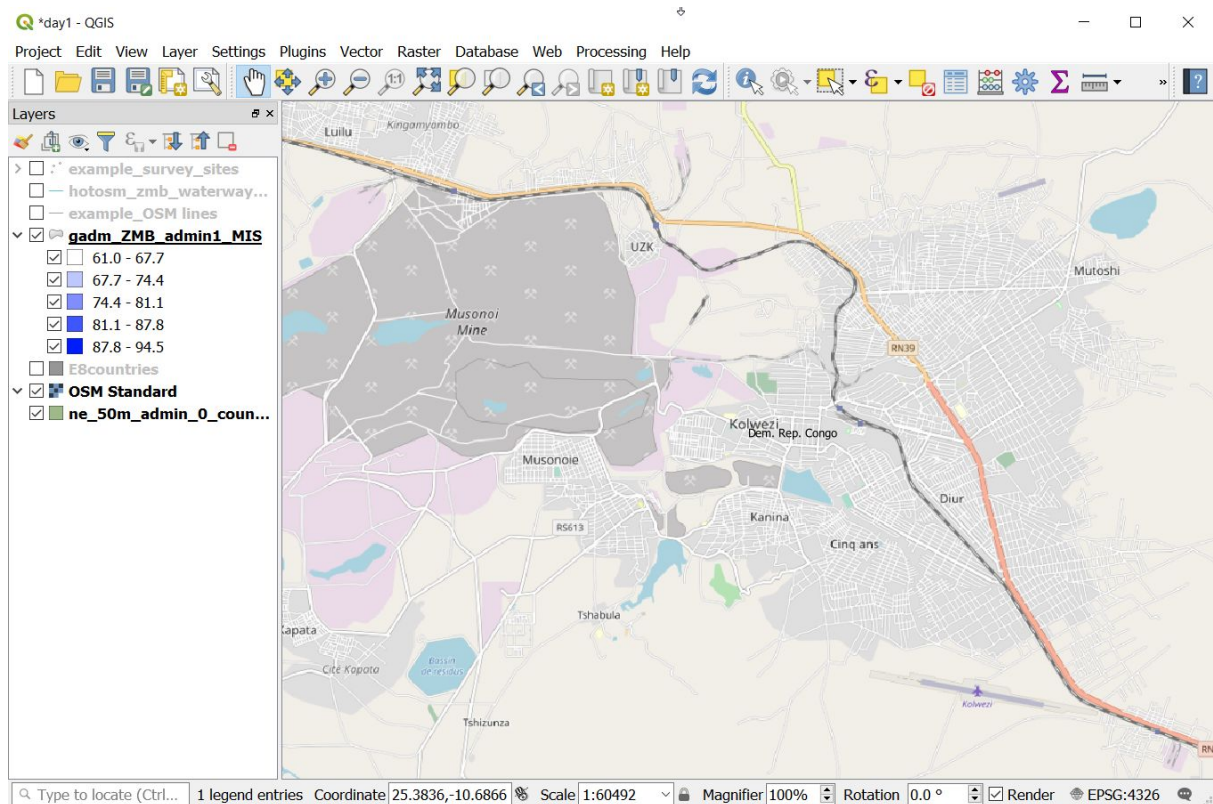

If you do not always have good access to the internet, you can download material that can be used as a base map offline, we will cover this later.

Symbology

Symbology determines how data are displayed on the map. For example, the colours used to represent the different spatial data, the selection of symbols used to represent points, the size of those symbols. Changing the symbology of your map can help communicate your data more clearly.

In the current example we have various layers in various styles, including polygons graduated by colour (light to dark blue) and red points graduated by size (small to large). Let's look at the points as an example.
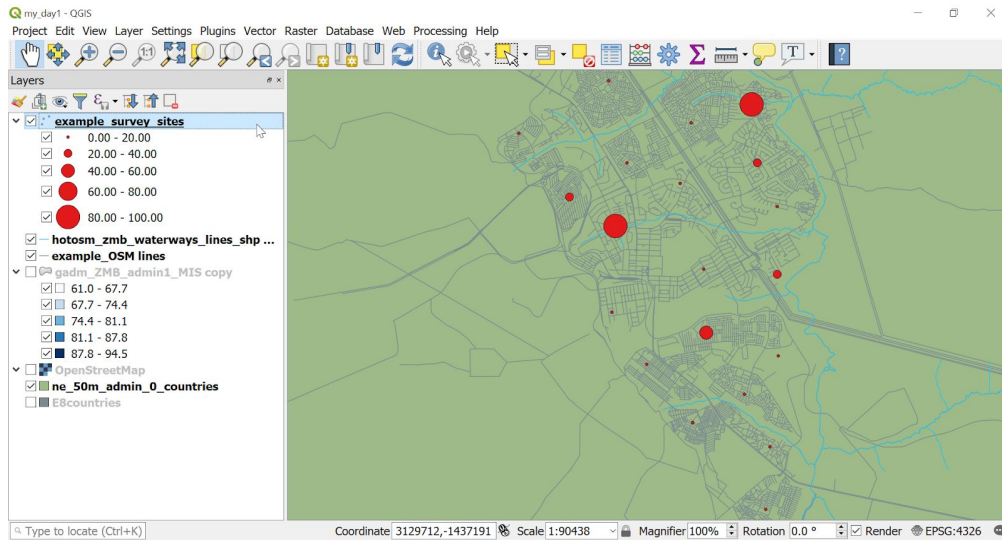
→ Select the points layer to make it visible and zoom to layer (right-click, Zoom to Layer)
→ Unselect 'gadm_ZMB…' and OpenStreetMap.
→ Select 'hotosm_zmb_waterways…' and 'example_OSM lines', to provide some context for the image.

Note that the red dots represent example survey sites and are displaying data in ranges of 20, between 0 and 100. (If you cannot see this detail listed, click on the small triangle to expand the information for the layer).

→ Right-click on the layer 'example survey sites' and select 'Properties'.
→ In the Layer Properties window that appears, select 'Symbology' from the list on the left-hand side.
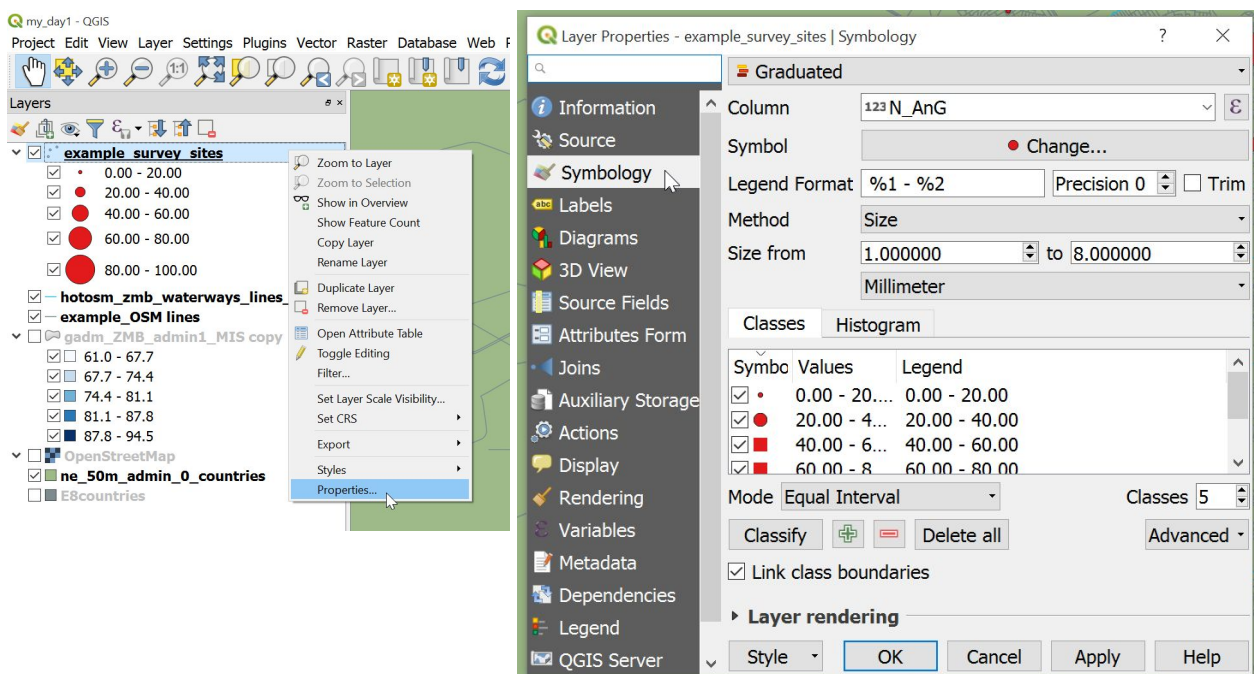
You will see that there are various options available to you to adjust. We don't need to understand them all immediately.

➔ Note that the first option at the top is a drop-down list with 'Graduated' selected.
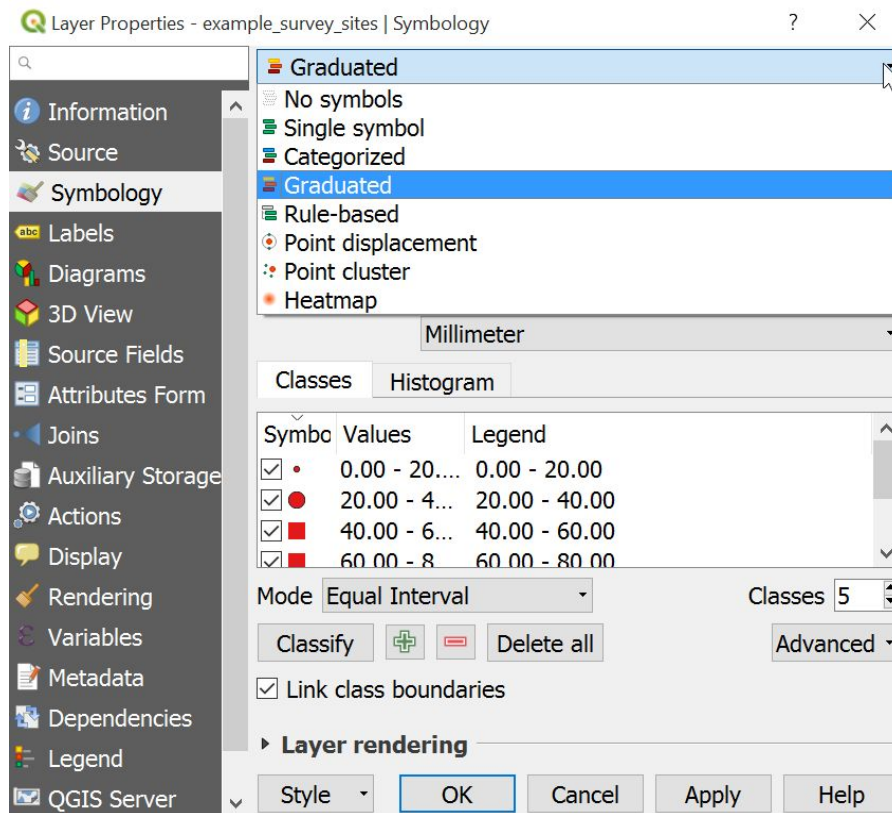

➔ The next option is 'Column', with another drop-down menu, currently set to 'N_AnG' (number of *Anopheles Gambiae s.l.* in this fictitious dataset). 'Column' is used to specify which variable should be used to graduate (or otherwise define) the data.
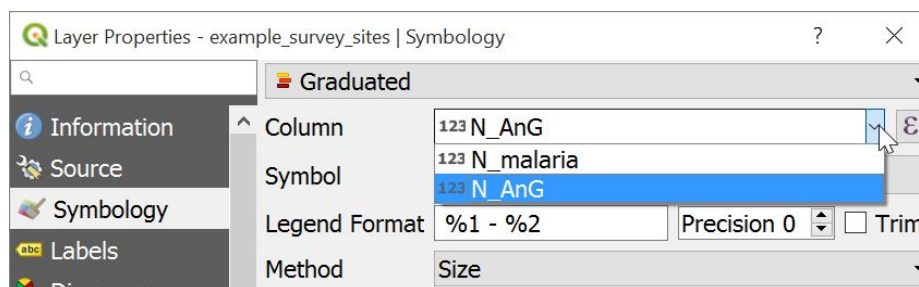


➔ Try changing this N_malaria (number of malaria cases).
➔ Click on 'Classify' lower down in the options. (This will re-classify the data range according to the data in the selected column, there are 0-3 cases per household, there were 0-100 mosquitoes)
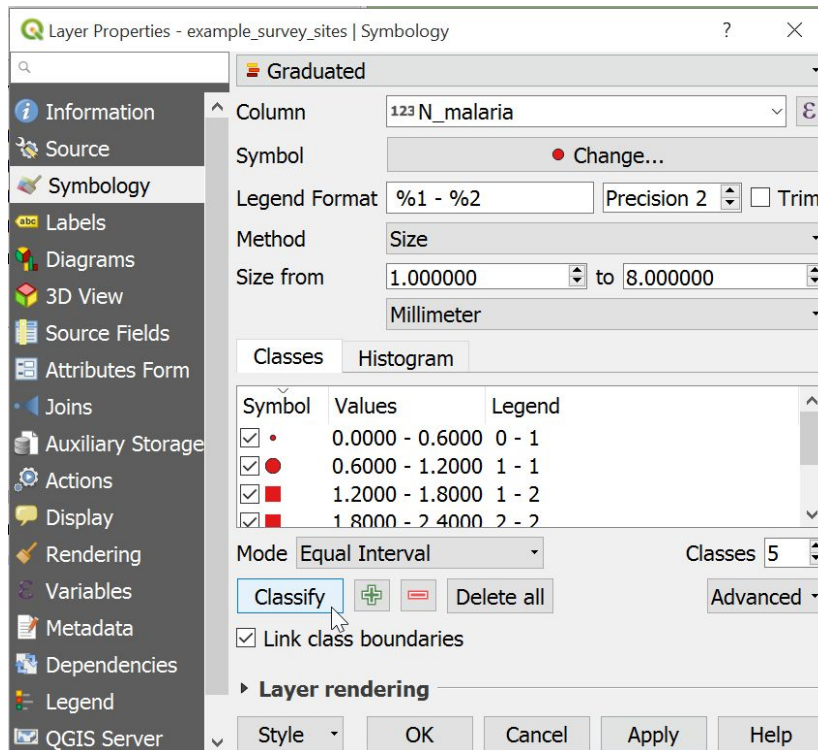
➔ Then click on 'Apply' to see this symbology applied to the points on the map.

Now each point represents the number of malaria cases found at that site, the bigger the point, the more cases there were.

Note that there are options available to change the number of classes and mode of classification. We are not going to go into detail on these at this point, but it can be important to think about this when classifying your own data.
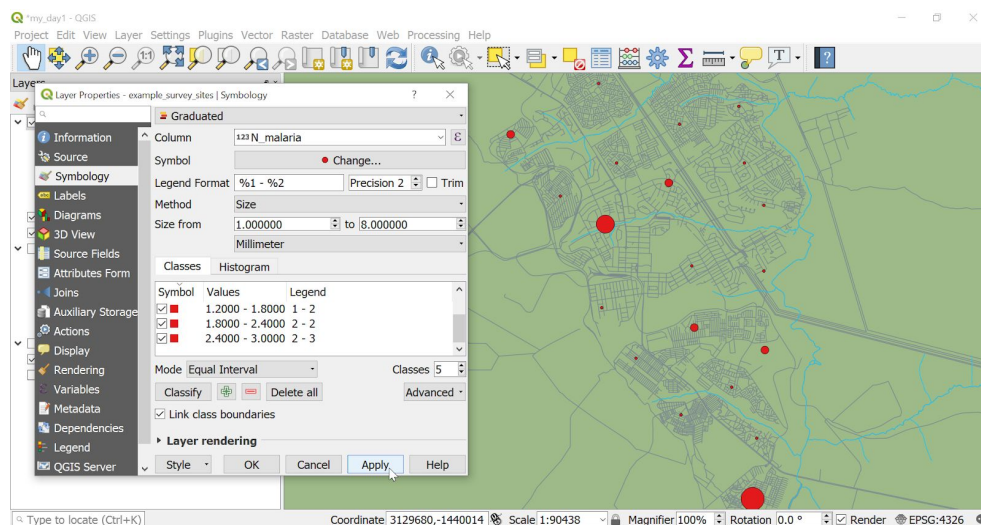

We can also use the colour of points rather than their size to represent attribute data.

➔ Re-open the layer properties window if you have closed it (right-click on layer of interest, Properties, select Symbology within window).
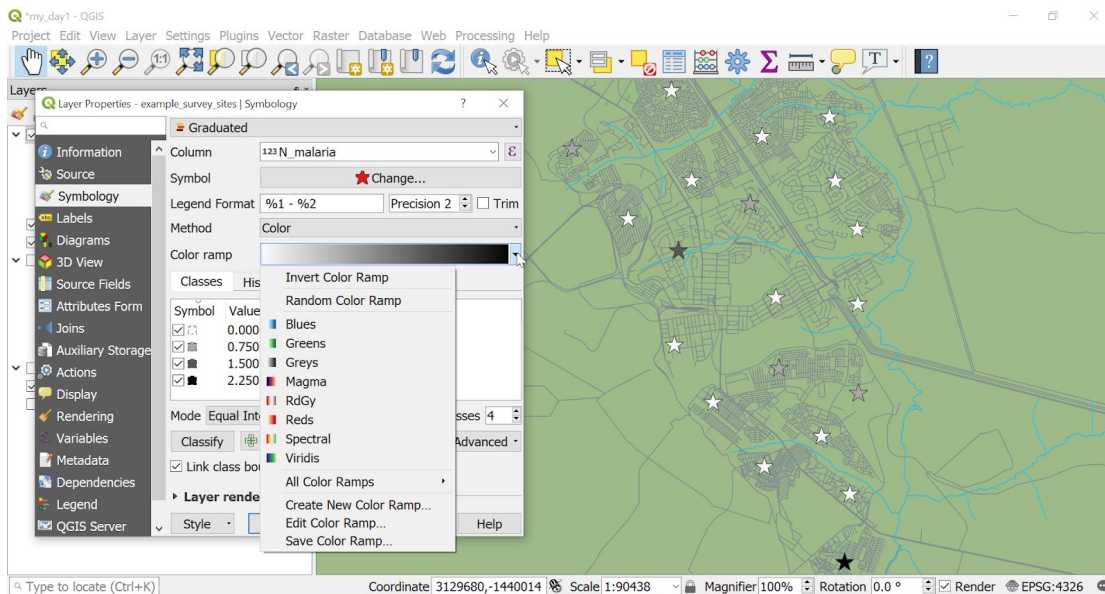
➔ Change Method from Size to Color.

➔ Click Apply

➔ Note that the number of cases is now represented by a scale of colour from white to red, where darker red indicates more cases.
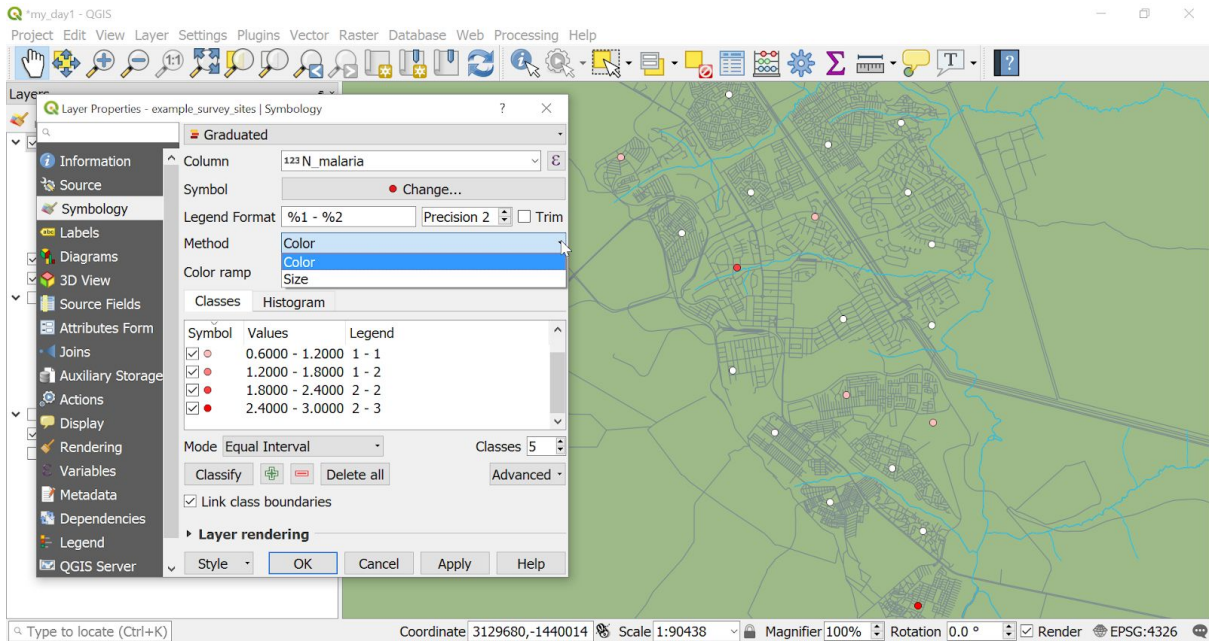
➔ The Symbol option allows you to change the shape and size of your markers should you wish.
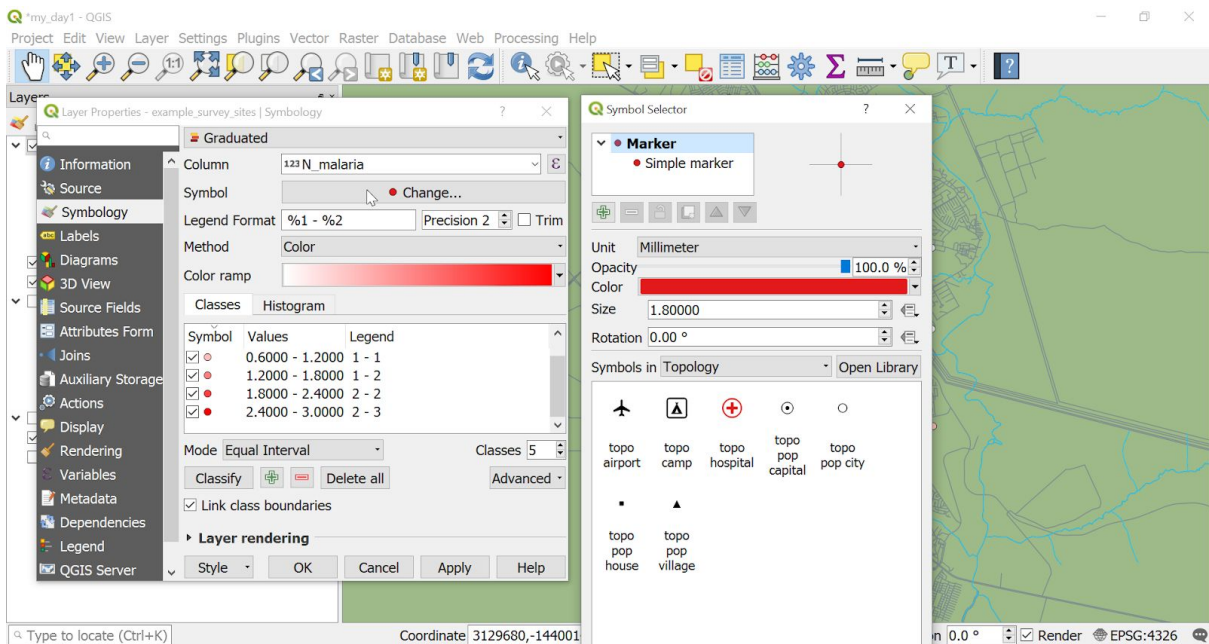
➔ Different colour ramps are also available for selection.

➔ Depending on your data, graduated points might not be the most appropriate option. Other common options would be Single Symbol and Categorized.

For example, imagine we want to create a map to show the locations the survey took place. The same survey was carried out, by the same team, on the same day, and all we want to show with our map is where the places they visited are. In this situation, there is no need for the points to differ in size or colour and Single Symbol would be a good choice.

To apply a single symbol to your data:
➔ Layer Properties window (Right-click on layer of interest, properties)
➔ Single Symbol
➔ Optional: change symbol and/or colour
➔ Apply
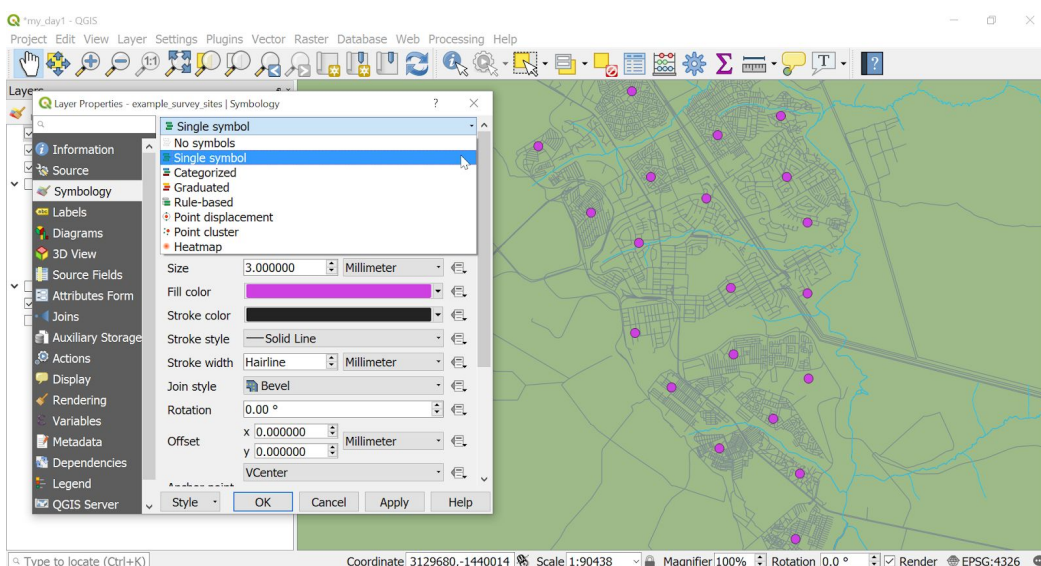
Now imagine that later in your report, you want to present some of the survey results. Mosquitoes that were collected were tested for resistance to pyrethroids. The mortality results were categorized according to WHO standards as susceptible, potentially resistant or resistant. Where no data was available a blank space was left in the dataset. Categorized could be a good option for this data.

The option categorized will create a separate category for each different value entered. If you have 100 different numbers for that variable, it will create 100 different categories, which will be assigned 100 different colours. Categorized can be applied to text fields, note that if there are different spellings of words they will be assigned their own category.

To categorize your data:
- ➔ Layer Properties window (Right-click on layer of interest, properties)
- ➔ Select Categorized
- ➔ Select the variable to categorize by from Column.
- ➔ Click Classify
- ➔ Click Apply

Click OK or cancel to close the layer properties window when you are finished with it.
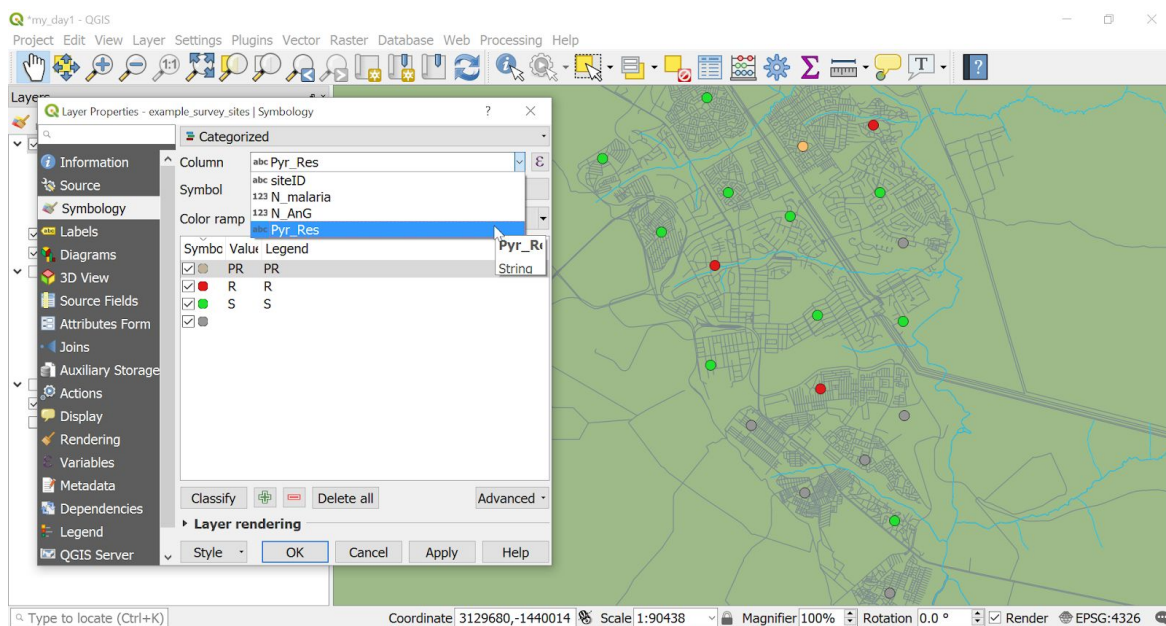
Similar options can be set for polygon and line layers via the Layer Properties window.

- ➔ Try changing the colours of the 'gadm_ZMB…' layer. There is some data taken from the 2015 national malaria indicator survey in the last three columns of the attribute table.

Remember how to see the attribute table?
- ➔ Right-click on layer, Open attribute table

P_HH1NET is the percentage of households who owned at least one net
P_HHMemSle is the percentage of all household members who slept under a net the previous night
P_HHIRS12M is the percentage of households sprayed in the previous 12 months.
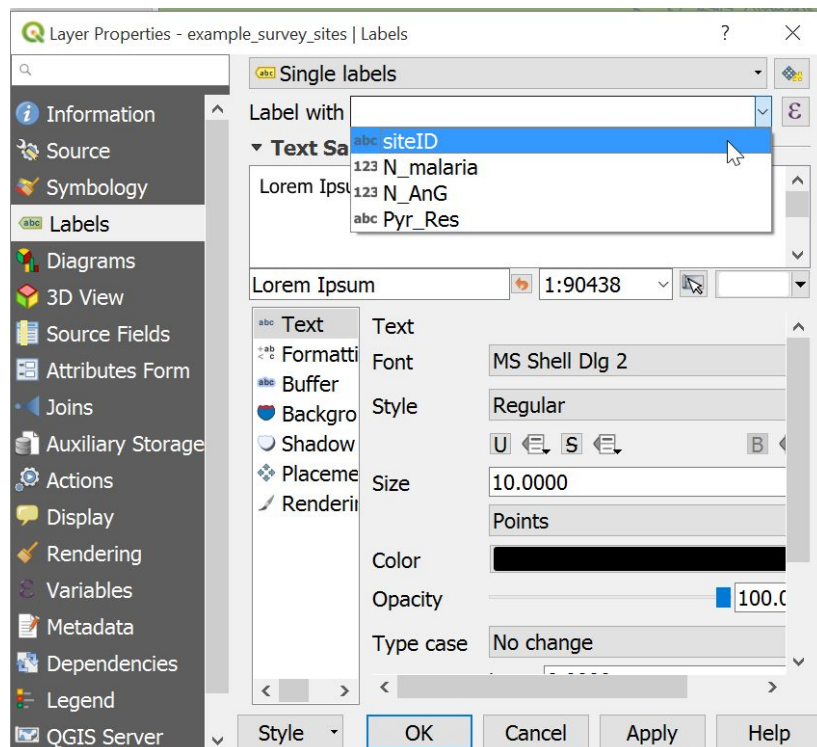
Labels

Labels allow us to put text on the map associated with vector data layers - points, lines or polygons. To do this we return to layer properties. Next to symbology is an option Labels.

➔ Right-click on the layer of interest (use example_survey_points)
➔ Properties
➔ Select Labels from the list on the left
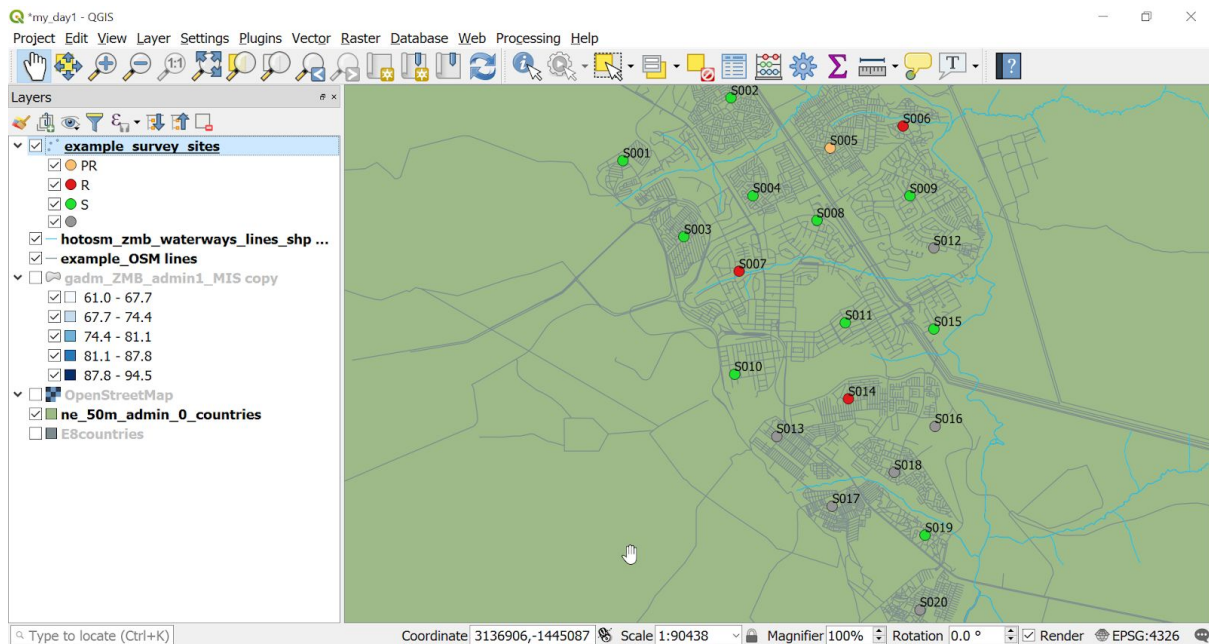➔ Change the drop-down menu from 'No labels' to 'Single labels'
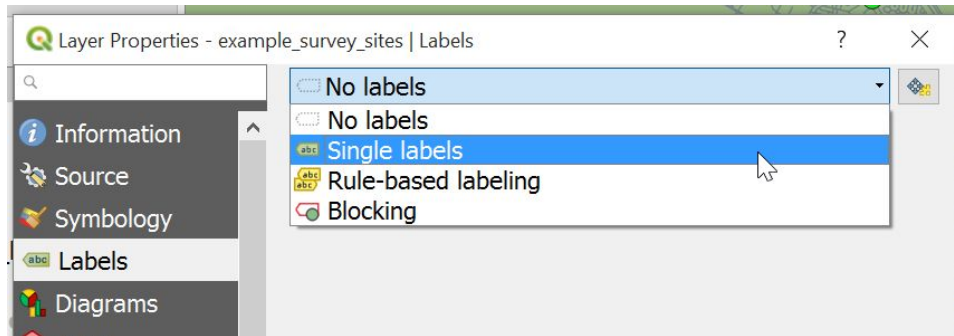
➔ Select the variable you wish to use as a label from the list in 'Label with' (use SiteID).
➔ Note you have options to format the font should they be required.
➔ Click Apply

Click OK when you have finished with the window. This will also apply the changes if you wish to skip the Apply step.

➔ Try adding labels to the layers, 'example_OSM lines' and 'gadm_ZMB…'

To check the data you have available to use as labels with you can look in the attribute table.

Now you have had a brief introduction to adding data to QGIS and changing how it is represented. We don't expect you to know everything and don't worry there will still be things that you don't understand. There are still parts of QGIS that we don't understand! However you now should know enough to start creating and modifying your own maps. Have a go at the Exercise below.

Exercise

Categorise and label the E8 countries by name.

Save your project.

Layouts

A common reason for creating a map is to visualise a situation and be able to present this to other people. It would not be convenient if anyone that wanted to see your map had to have QGIS installed and access to all the layers of spatial data involved. Therefore there is a function for preparing a map ready for export as a simple image or PDF that can be more easily shared. This feature also allows for other formatting, such as adding scale bars, legends and titles to aid interpretation of your map. This feature is called 'Layouts' (previously 'Print Composer' in version 2 of QGIS).

New Print Layout

➔ You will need a map open to work with. If you don't have a project open, open one (for example day1 or my_day1)

➔ Open a new print layout by one of the following routes:
- ◆ Menu bar: Project, New Print Layout
- ◆ Shortcut keys: Ctrl+P (Print)

- ◆ Toolbar icon (you will need to add the Project toolbar to see this):

➔ Name your layout when prompted (for example my_first_layout) and click OK.
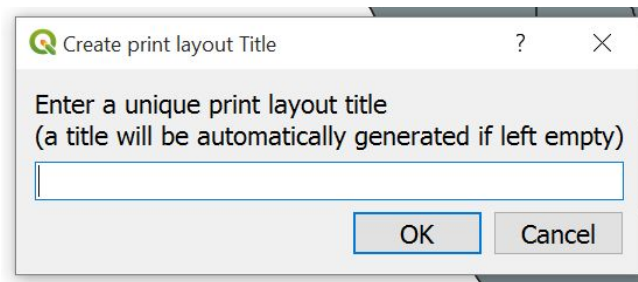
➔ A new layout window will appear that looks as follows.
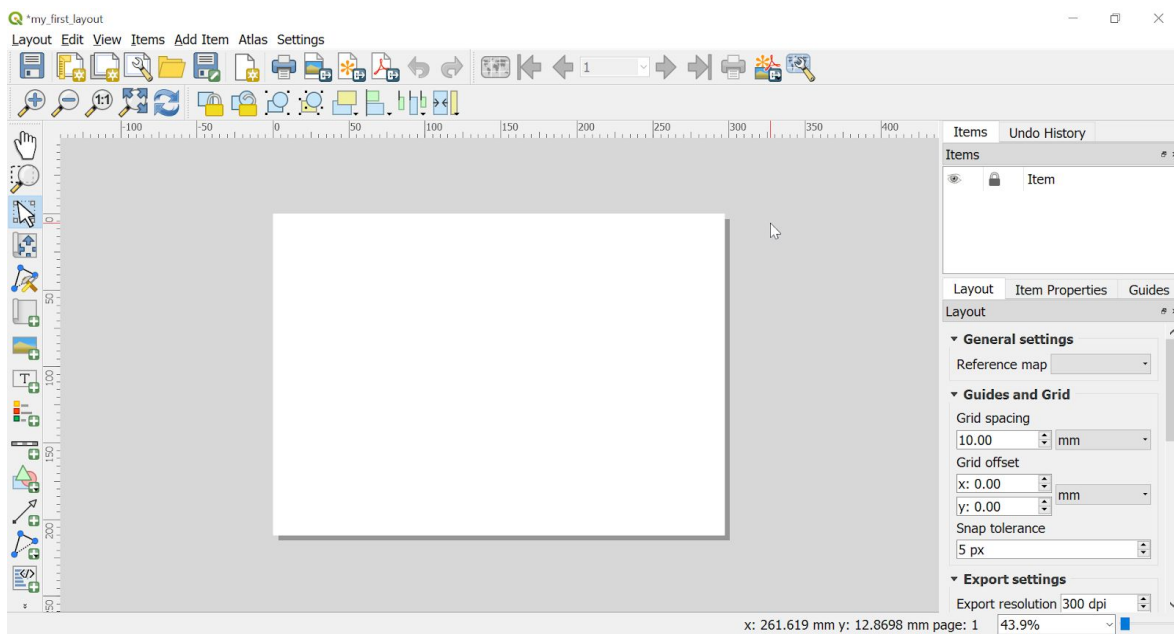
➔ The layouts window is similar to the project window, with a menu bar, toolbars, and panels. Instead of the map there is a blank page where you will add and arrange your map and other items.

Once again, there are many options available to us. We will go through some of the basics. Remember you can hover your cursor over buttons to see what they do and explore further options.

➔ Once you are familiar with the icons, the toolbar down the left-hand side is very useful.
➔ To get started you may wish to use the same options via the menu bar.
   ◆ The 'Add Item' and 'Edit' menus are useful for getting started.
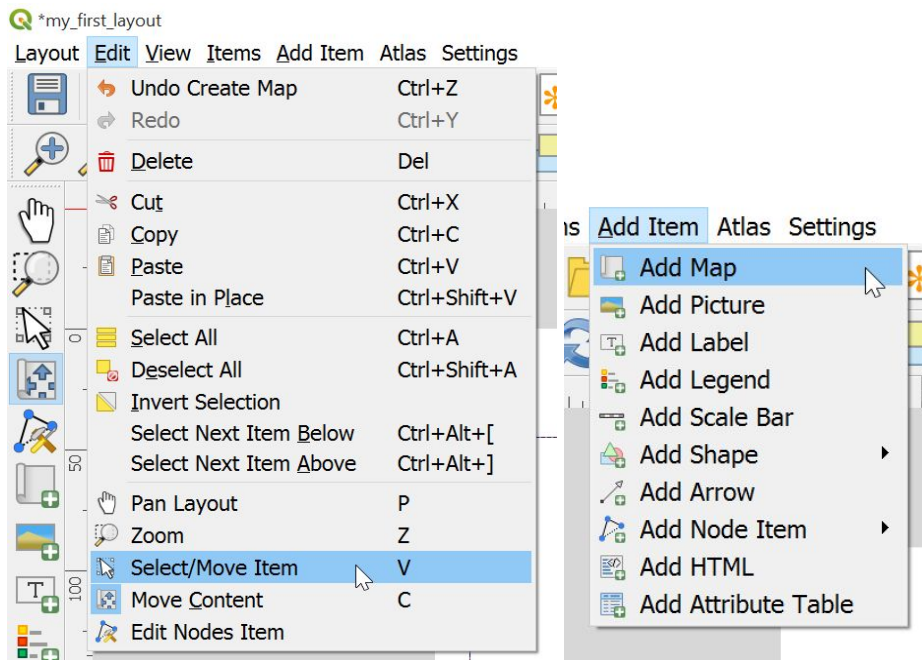
Add map to layout

➔ Click the 'Add Map' option to select it from the toolbar or menu (Add Item).
➔ Move your mouse onto the page, you will see your cursor as the following symbol.
➔ Hold down the left button of your mouse and drag a rectangle shape on your print canvas. When you release the mouse button your map will be displayed in the rectangle you have created.

Select/move item in layout

You can change the size and position of added items by activating the the "Select/Move Item" button.

➔ This may be the default mode after adding your map, but can also be found as an option in your toolbar, via the menu under "Edit", or using the shortcut key "V".

➔ To change the position of your map on the page, use your left mouse button to drag and drop your map rectangle. Left-click on your map and hold down the mouse button as you use your mouse to move the map to the desired place on the canvas; release the button when the map is in position.

➔ To make your map smaller or larger, move the cursor of your mouse to the corner of your map, when it changes from a single-headed to a double headed arrow ( ) hold down your left mouse button and move your mouse to make the rectangle of your map smaller or larger. When you are happy with the size, release your mouse button.

Move content

To change the position of your map within the box you have drawn, use the Move Content button.

➔ Select the Move Content tool (from the toolbar or under Edit in the menu).

➔ Drag and drop your map to reposition what is visible, or zoom in and out using your mouse wheel. Note that by holding down the Ctrl button when you scroll allows you to zoom by smaller increments.

Zoom

This tool is for zooming in and out on your whole layout canvas. You can use the scroll of your mouse, or drag a rectangle to select the area you wish to zoom in on.

Add Scale Bar

➔ Click on the icon to select it (toolbar or Add Item from Menu)
➔ Click somewhere in your layout page and a scale bar will appear.

Use the "Select/Move item" tool to reposition as required. Notice guidelines will appear automatically to help you align the item with other objects on the canvas, such as the map.

Editing a Scale bar - Item Properties

➔ Use the "item properties" panel to edit your scale (right hand side of the window).
➔ If it has been closed or hidden, the menu can be used to reopen it; go to "View", "Panels", then tick "Item properties", or you can right-click on a panel or toolbar to access the list as with the main map window.

As usual there are many options available to customise your item.

➔ Note that under "Main properties" there is an option "Map" where you can choose which map the scale bar is attached to (should you have more than one map present), and the option "Style" is also featured, which offers a drop down selection of available scale styles.
➔ It is also possible to select which units will feature on your scale bar. Remember that the scale bar should provide useful information and context for the person reading your map, make sure you choose appropriately. Should the units be in meters, kilometres, nautical miles, feet, miles? Select the option that makes most sense for your map.
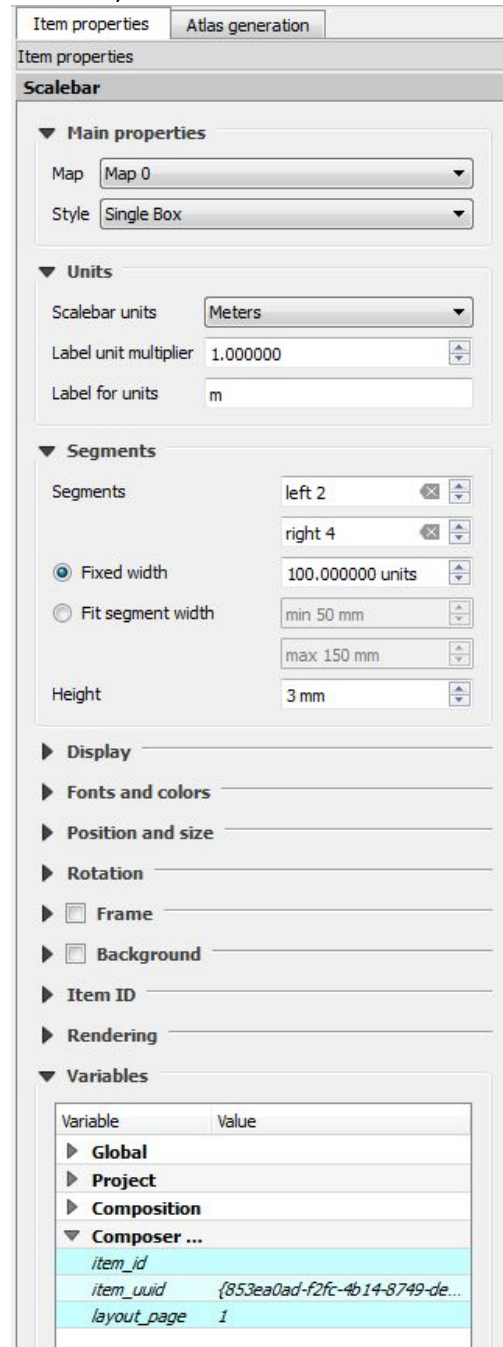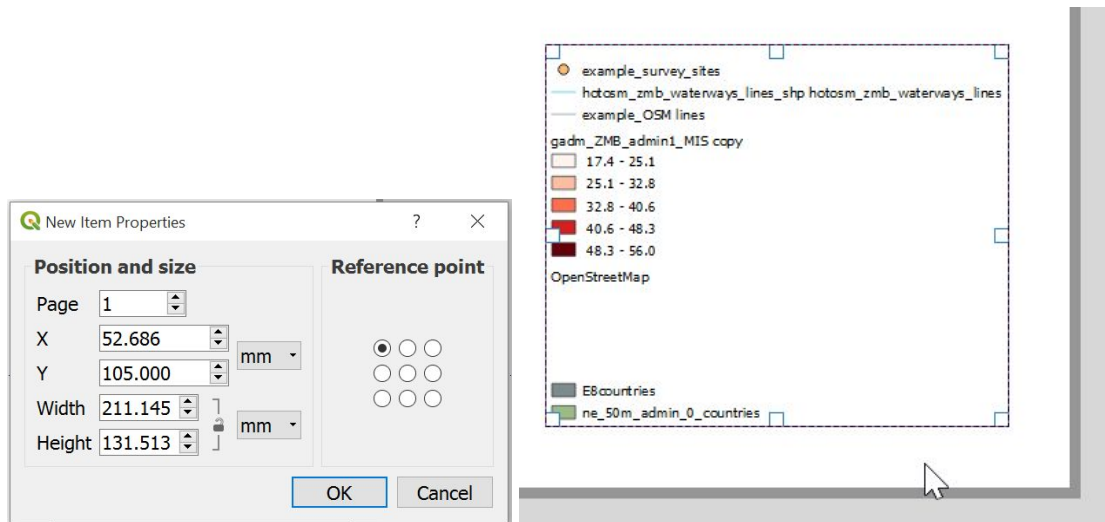
Add Legend

A legend can provide important information to the map user on how to interpret the information presented.

➔ Select 'Add legend' (toolbar or Add Item Menu)
➔ Click on the page

➔ Click OK on the New Item properties window that appears (adjust position and size here if desired).

➔ A list of all the layers present in your project will appear.


Editing a legend - Item Properties

Your legend should be meaningful to all those who might read your map.

❖ Make sure that the labels used are informative and will make sense to others.

❖ Units should be displayed where appropriate.

❖ Numbers should be formatted correctly.

The legend can be edited within the "item properties" panel.

➔ If you have just added the legend, this item will by default be selected in your canvas. If for whatever reason it is not, use the select/move item tool and click on the legend in the print canvas to select it. The item properties panel will show options for the selected feature only.

➔ The legend panel in item properties offers various options for modification of your legend (see figure). Click on the triangles to expand each of the categories and reveal the various editing options they contain.

➔ Expanding the "Legend items" category for example will reveal a list of layers and an editing toolbar. The items listed in this panel in the print composer reflect the layers in your main QGIS map canvas.
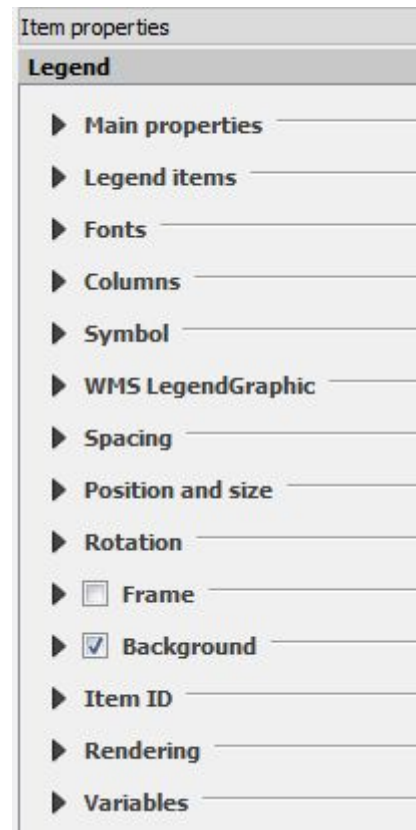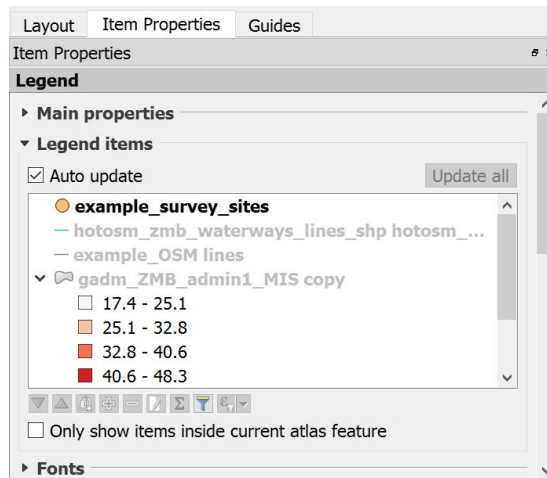
➔ If 'Auto Update' is selected, changes made in the map canvas will automatically be updated in the item in the layout.

➔ To manually edit your legend from the layout, unselect this option. This will activate the greyed out buttons in this section.
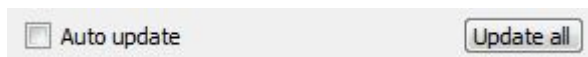
 The order of legend items can be changed using the up and down arrow buttons, or by dragging and dropping within the list itself.

 Layers can be added or removed using the plus and minus buttons.

 The text of each item can be edited using the button with a pencil and paper, or by directly double-clicking on the text in question. Use this to make sure your labels are meaningful. For example, what are displayed are your layer names, which by default are the names of those files. This may mean something to you, but may not be clear to others. It will also not reflect any manipulation you have made to how the information is displayed – what do your graduated colours represent? Are there units for the categories chosen? Changing the labels of your legend is a simple but effective way of making your map more informative.

The text of the legend title can edited within "Main properties", "Title".

Save project

When you are happy with your map layout, save your project using the icon in the toolbar, the option in the menu under "Layout", or the shortcut key "Ctrl"+"S".

Exporting your map layout

You can print or export your map as an image or PDF file to share it with others as a hard copy or via email etc.

➔ Click on the appropriate icon from the toolbar along the top of the screen, or find the options in the menu under 'Project'
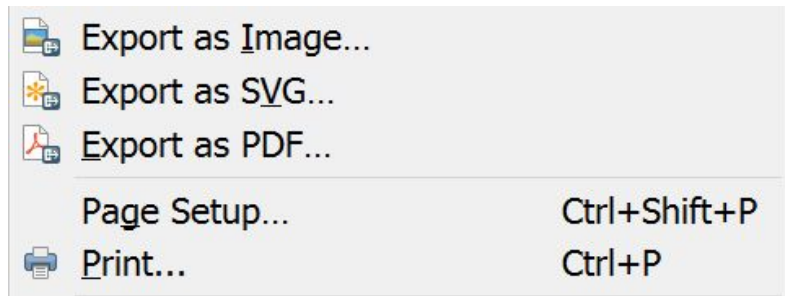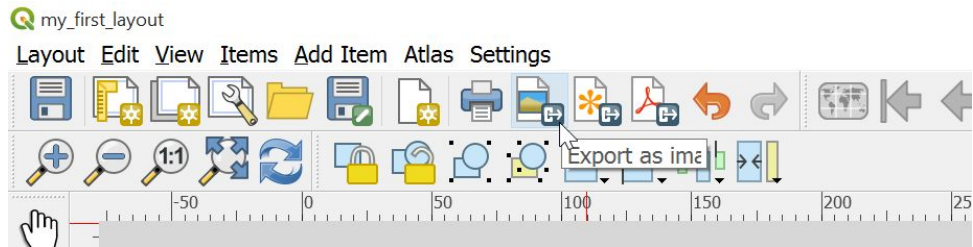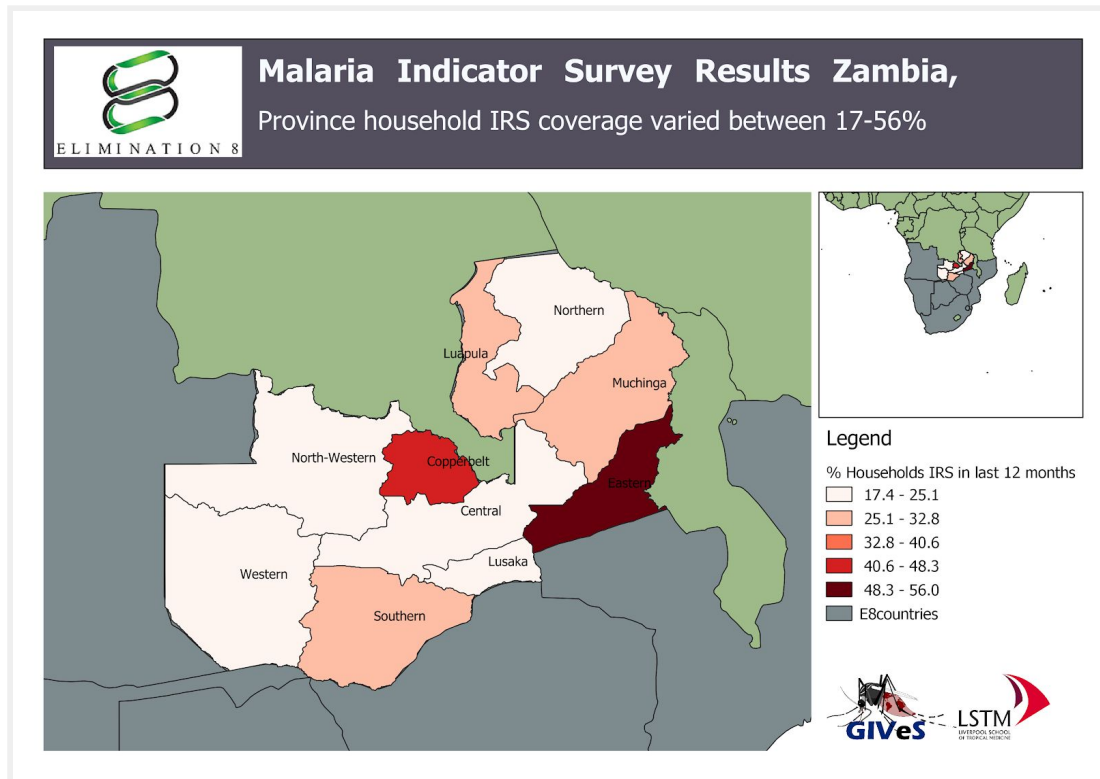

➔ These export options will open a "Save Layout as" window, where you will be able to select your desired file type, a destination folder, and give it a name.
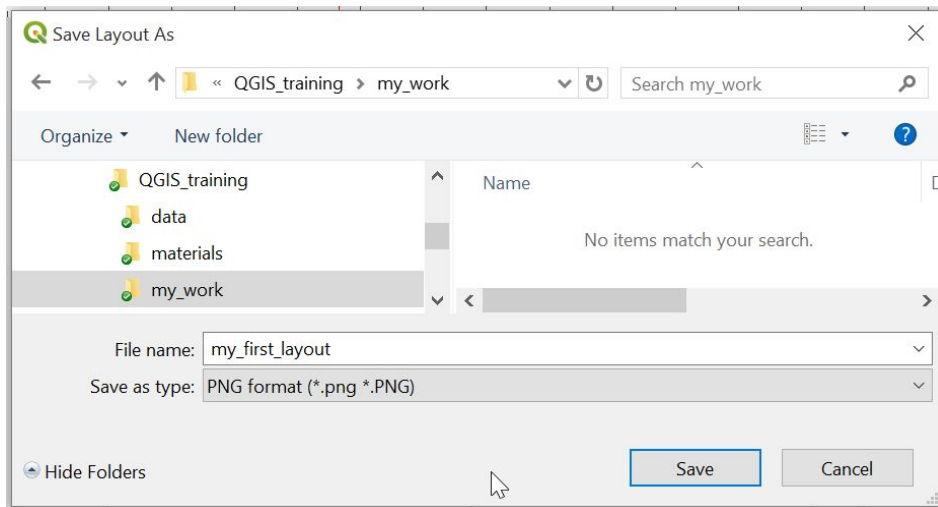
Exercise

Produce a map layout. You can use the my_day1 project.

Below is an example to give you some ideas.

End of Day 1