

Lesson 2 - Introduction to QGIS

1. Objectives

This lesson will introduce the QGIS software. This lesson will largely be practical, to allow you to get to grips with the QGIS interface. We will see how to add, manage and visualise vector and raster datasets, and how to compose a map within QGIS.

- Introduce QGIS and the QGIS interface
- Save a QGIS project
- Add and visualise vector data in QGIS, view the attribute table, and change vector symbology
- Add and visualise raster data in QGIS and change raster symbology
- Compose a map in QGIS

2. Software

The software used in this lesson is the current Long Term Release (LTR) QGIS 3.16.4 Hannover

3. Data

The data used in this lesson can be downloaded from Canvas in the zip file **Lesson2_Data.zip**. **within this folder are the files:**

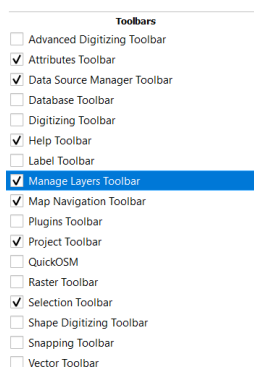
Data file	Detail	Source
amenities.gpkg sudan_railways layer	Vector line layer of railways in Sudan (within amenities GeoPackage)	Open Street Map (03/03/2021) http://download.geofabrik.de/africa/sudan.html
amenities.gpkg sudan_health_facilities layer	Vector point layer of health facilities in Sudan (within amenities GeoPackage)	WHO (2019) https://data.humdata.org/dataset/health-facilities-in-sub-saharan-africa Data has been clipped to include only health facilities in Sudan.
khartoum_waterways.shp	Vector polygon layer with water bodies and rivers in Khartoum	Open Street Map (03/03/2021) http://download.geofabrik.de/africa/sudan.html Data has been clipped to include only the area around Khartoum
Sudan_admin1.shp	Vector polygon layer with the administrative boundaries for States in Sudan	GADM v3.6 (2018) https://gadm.org/
worldpop_khartoum_buildings.TIF	Raster layer on the urban and rural built-up areas in and around Khartoum.	Worldpop (2020) https://wopr.worldpop.org/?SDN/Buildings Data has been modified for the purpose of this tutorial

4. Personalising the Graphical Interface (toolbars and panels)

It is possible to add and remove toolbars and panels, depending on which ones you use the most and wish to have visible.

You can add and remove toolbars via the Menu: **MENU View ► Panels...** or **MENU View ► Toolbars...** or with a right click on the existing toolbars, the same list will appear. Click on the check boxes to add or remove toolbars or panels.

- **Add the Manage Layers toolbar**



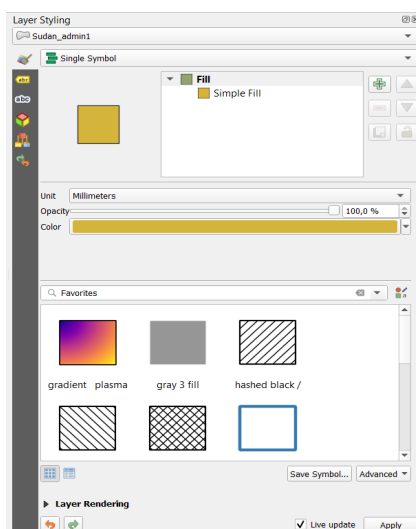
The **Manage Layers** toolbar will now appear on the left-hand side of the QGIS interface. This toolbar contains tools for adding various different data types, or to create new layers. We will come back to this toolbar later.

- **Add the Manage Layers toolbar**

We will also now add the **Layer Styling** panel.

- **MENU View ► Panels ► Layer Styling Panel ► Symbology tab**

The panel will appear on the right-hand side of the GIS interface. It provides a shortcut to layer styling functionalities (changing colours, adding labels etc). We will come back to this later on.



5. Saving a QGIS project

The state of your QGIS session is called a project, and this state can be saved into a QGIS **project file**. This means you can close a project and open it up again to continue from where you left off. Any

operations to do with saving, opening, or creating a new project can be found via **MENU Project**. A project file is saved in QGZ format (i.e. a .qgz extension).

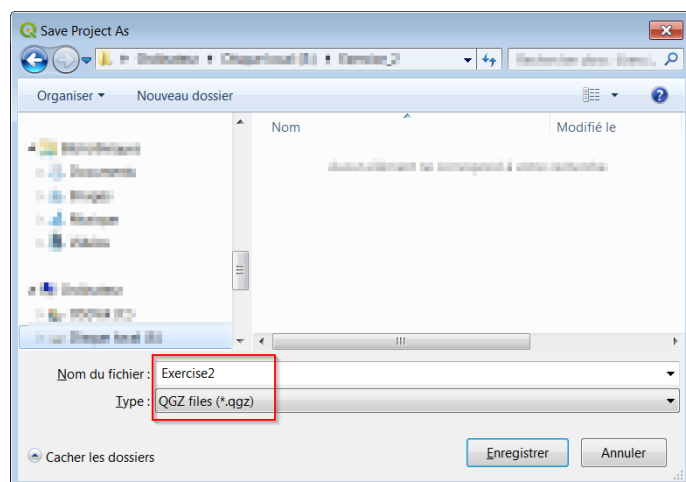
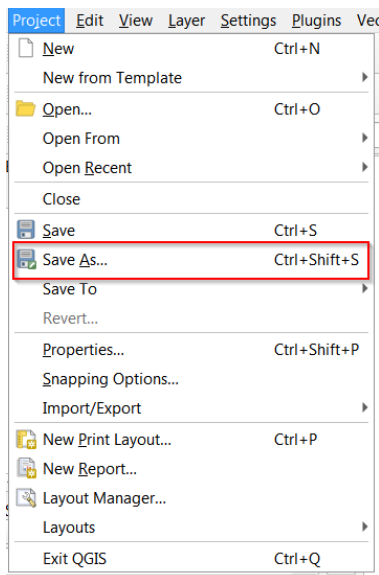
The **project file** saves a lot of information about the status of the project, including the layers added, their properties (e.g. symbology) etc. but **it is important to note that the data itself is not saved in the project file** - only the **relative** path to the data source.

This means **that it is important not to change the location of the data relative to the location of the project file** (i.e. to not move the data to different folders once the data has been added to QGIS, as QGIS will no longer be able to find it).

Another example, when sharing a QGIS project with others, you must also share the data which is used in the project (keeping the same path logic between the project and the data).

- **Save the QGIS project**

Save the project as a .qgz file in the folder that contains the material for Lesson 2 (**MENU Project ► Save As...**) e.g. (...\\Lesson_2\\Lesson2.qgz). **It is important to save your work regularly!**

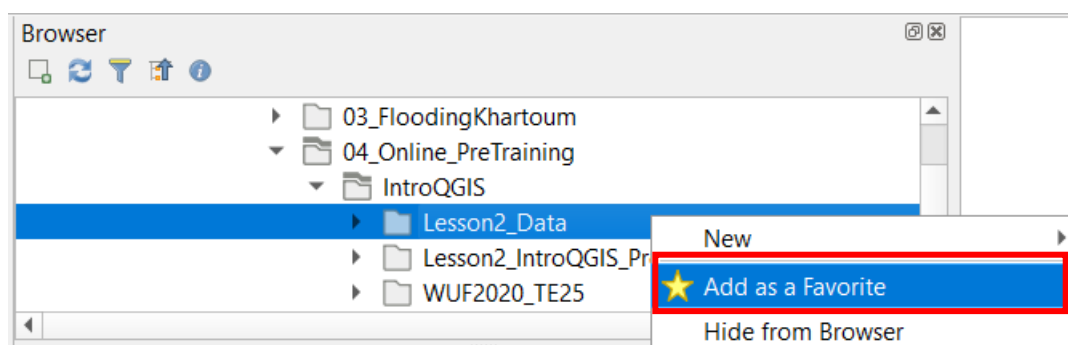


6. Adding a folder as a favourite

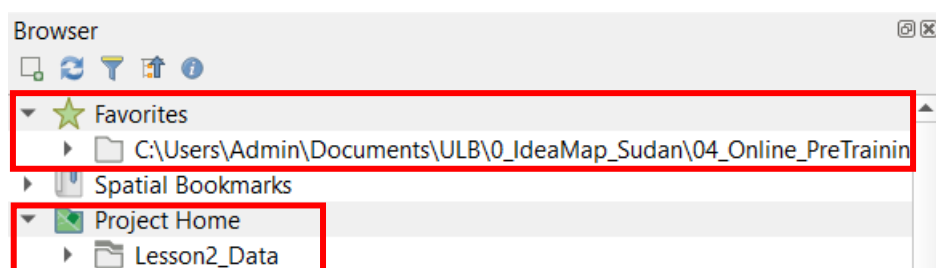
In the Browser panel, it is possible to create shortcuts to the folders in which your data is stored. This means you can quickly access your data to add them to QGIS.

To do so, in the **Browser panel**, navigate to the folder containing the data for this lesson (Lesson2_Data). Right click on that folder and select **Add as a Favorite** from the drop-down menu.

- **Browser panel ► Navigate to the folder containing the data for this lesson ► Right click on the folder (Lesson2_Data) ► Add as a Favorite**



This will allow you to find the data more easily in the next steps, as the **Favorites** appear on top of the list of folders. Alternatively, if the QGIS project is in the same folder in which your data is stored, this can also easily be found via **Browser panel ► Project home**



7. Vector data in QGIS

Vector data is made up of either point, line, or polygon geometry. A vector layer can only be made up of one type of geometry (i.e. it is not possible to have points and polygons in the same vector layer). Each vector layer is associated with an attribute table. These attributes describe the elements in a vector layer.

There are many different formats in which vector data can be stored. The most well-known is the ESRI **Shapefile** (extension .shp), but others such as .kml and .geojson are also commonly used. All data formats compatible with GDAL/OGR are also compatible with QGIS (<https://gdal.org/drivers/vector/index.html>).

The new standard format is now the Geopackage (extension .gpkg). This format has the advantage that it allows the storage of multiple GIS data (layers) in a single file. Unlike the ESRI **Shapefile** format, a single **GeoPackage** file can contain various data (both raster and vector), in different coordinate reference systems, as well as tables without spatial information and layer style files, amongst other advantages. These features allow you to share data easily and avoid file duplication. For more information on the **GeoPackage**: <https://www.geopackage.org/>

Adding vector data to QGIS

There are a number of methods that can be used to add data into QGIS, and many different data types.

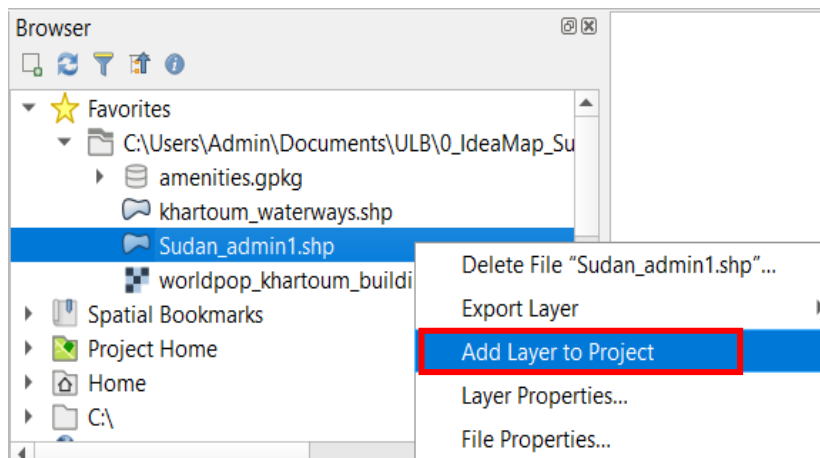
Method 1 – Via the Browser panel

In the QGIS **Browser panel**, navigate to the folder containing the data for this lesson. You can also directly access the data from the folder added to the **Favourites** earlier.

- **Add the file Sudan_admin1.shp.**



There are 3 ways to add data from the Browser panel: **Browser panel ► Navigate to the exercise files ►**

- Right click on the file ► Add Layer to Canvas/Project
- Double click on the file
- Drag and drop the file into the Layers panel



Method 2 – Via the Data Source Manager

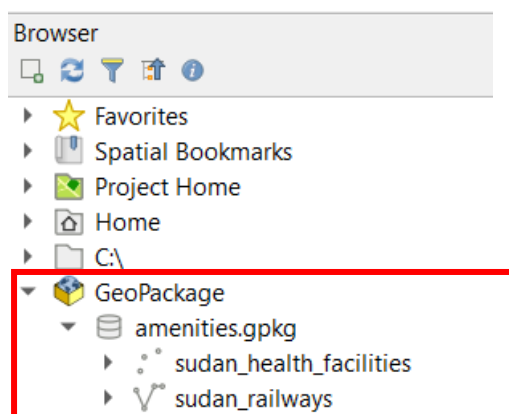
The **Data Source Manager** can be accessed via 2 ways:

- Via the symbol  which can be found within the toolbars, on the left-hand side of the QGIS interface.
- Via **MENU Layer ► Data Source Manager**. There are different tabs depending on the type of data you wish to add.
- To add vector layers, you can also access the **Data Source Manager** by clicking on the **Add Vector Layer** symbol  which can be found in the **Manage Layers** toolbar (toolbar that we added at the beginning of the practical).

We will use the **Data Source Manager** to add vector data from a **GeoPackage** database.

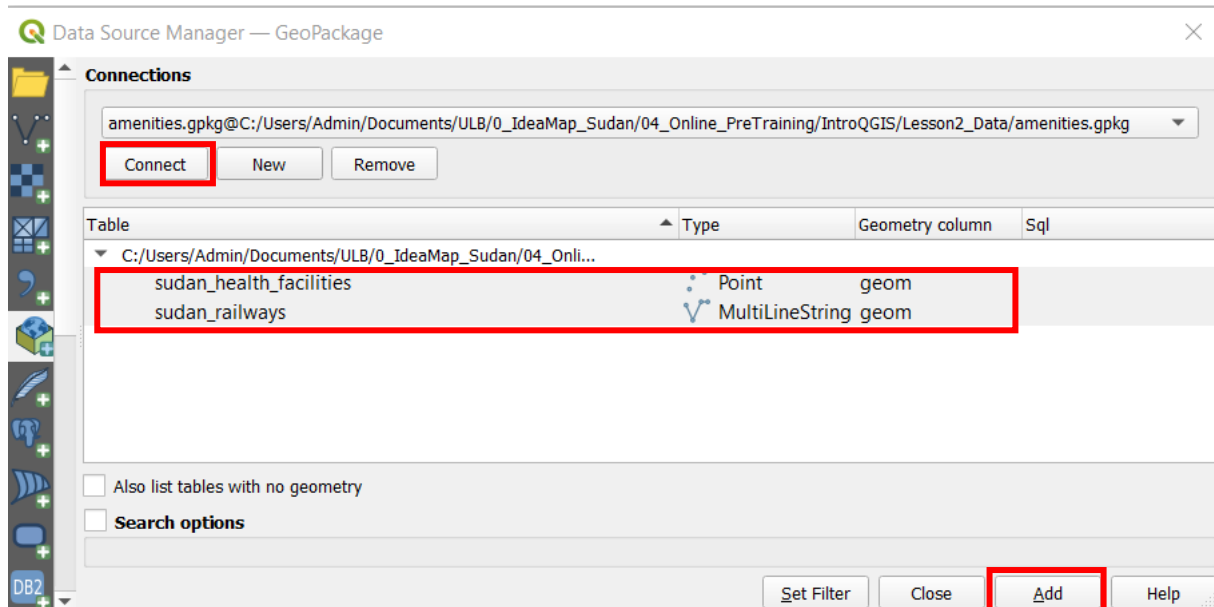
- **Data Source Manager**  ► **Click on GeoPackage tab**  ► **Click on New** ► **Navigate to the exercise files** ► **click on amenities.gpkg** ► **Open**

The file path is now added to the **GeoPackage** connections list. In addition, the **GeoPackage** will also appear in the drop-down menu in the **Browser panel**, allowing an easy access.

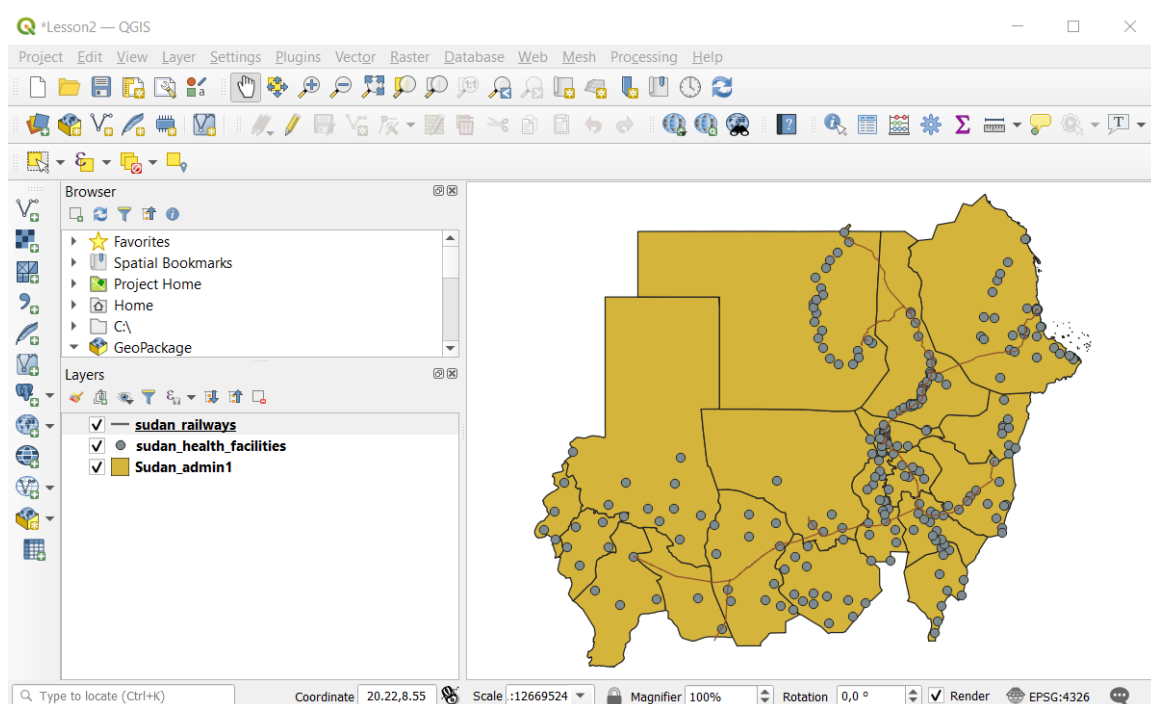


We can now add any layers from this **GeoPackage** to QGIS, either from the **Browser panel** (using the same three ways outlined in **Method 1**), or by connecting to the **GeoPackage** in the **Data Source Manager**:

- **Connect ► Select the layers *sudan_health_facilities* and *sudan_railways* (CTRL + click for a multiple selection) ► Add ► Close**



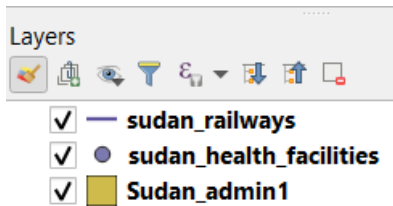
The layers are now listed in the **Layers panel**, and visible in the **Map View**.



Remember to regularly save the project (**MENU Project ► Save**)

Visualising data layers

In the **Layers** panel, is a list of the layers present in the project. The check box shows whether the layer is visible or not. The symbols at the beginning of each layer name, indicate which type of vector is present (point, line or polygon) and the symbology of the layer.



The order of the layers in the **Layers list** controls the order in which they are displayed in the **Map view**. The priority of visualization follows a top to bottom rule, which means that the top layer overlays the others. You can change the order of the different layers, or visualize various layer combinations by ticking and un-ticking layers.

Currently we can see all the data layers, but what happens if you drag the layer **Sudan_admin1** to the top of the layer list? Drag it back to the bottom, so that we can see all the data layers.

To get a complete view of a layer in the **Map View**, you can **right click on the layer name in the Layers panel ► Zoom to layer**. This focuses the Map View on the largest possible zoom of the layer, while still being able to see the entire layer.


First, in the **Map View**, zoom in so that you can no longer see the outer boundary of Sudan. Now **right click on the layer Sudan_admin1 in the Layers panel ► Zoom to layer**

Attribute table

An important characteristic of vector data is that in addition to their geometry, they have an attribute table, that describe the elements in a vector file. Attributes can be used, for example, to symbolise elements (e.g. colour and style), create labels, to quickly search for specific elements, or to spatially analyse vector data.

- **Open the attribute table of the sudan_health_facilities layer**

To open a vector attribute table, you must first select the layer in the layers list. You will know that a layer is selected when it is highlighted (in blue or grey). You can then either

- Click on the **attribute table** icon (in the **attribute toolbar**) 
- **Select layer ► Right click ► Open attribute table**

We can see that in total, there are 266 elements (health facilities) in this vector layer. Each element is represented by one line in the **attribute table** (and by one point in the **map view**). Each column (known as a **Field**) represents a different attribute, e.g. the **Field Admin1** gives information in which administrative state the health facility is found.

- **Which column gives information on the name of the health facility?**

There should always be field that contains a unique value for each element, so that it is possible to identify each element individually. In the layer **sudan_health_facilities**, this unique column has the name **fid**.

sudan_health_facilities - Features Total: 266, Filtered: 266, Selected: 0

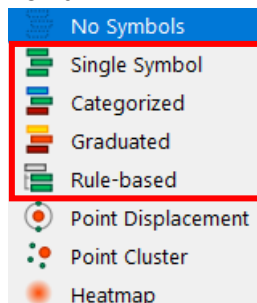
	fid	Country	Admin1	Facility n	Facility t	Ownership	Lat	Long	LL source
5	5	Sudan	Blue Nile	Ad Damazin Ho...	Type D Hospital	Govt.	12,3071	34,2784	GPS
6	6	Sudan	Blue Nile	Al Kurumuk1 H...	Type D Hospital	Govt.	10,0858	34,1696	GPS
7	7	Sudan	Blue Nile	Al Kurumuk2 H...	Type D Hospital	Govt.	9,7242	34,0887	GPS
8	8	Sudan	Blue Nile	Al Roseires1 Ho...	Type D Hospital	Govt.	12,2545	34,5294	GPS
9	9	Sudan	Blue Nile	Al Roseires2 Ho...	Type D Hospital	Govt.	12,1046	34,3605	GPS

Show All Features

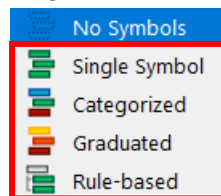
Vector symbology

The term symbology refers to the choice of colour and style of the layer. There is a wide variety of options and combinations. In QGIS, different types of symbology are available for vectors, depending on their geometry (point, line, polygon). The main ones are the single symbol, categorized, graduated and rule based. These will be covered in more detail in a future lesson.

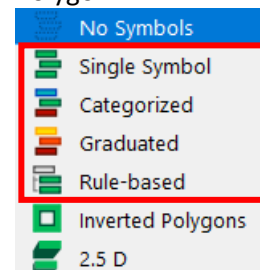
Point



Line



Polygon



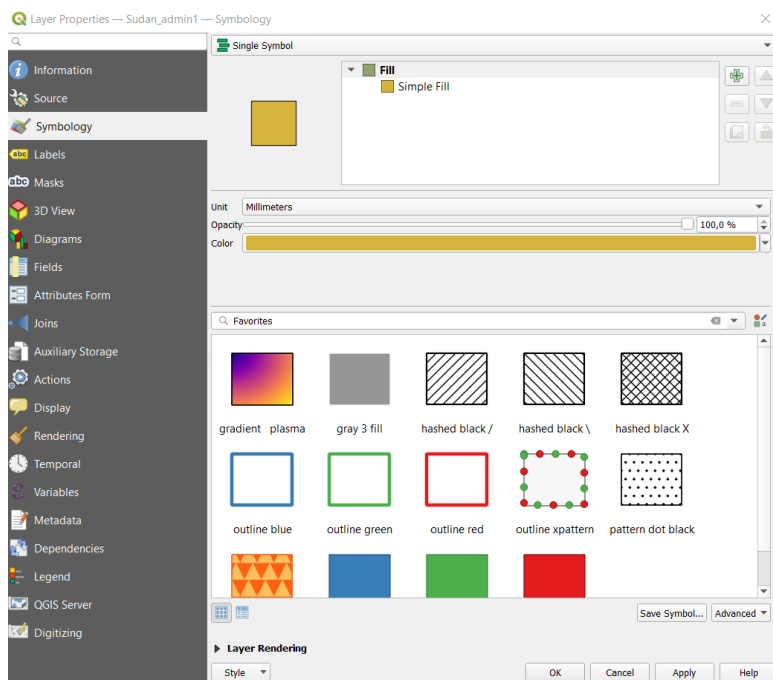
There are two ways to access the symbology of a layer:

Method 1: Via the **Layer Properties Dialog** (2 ways to access)

- Select layer ► Right click ► Properties ► Symbology tab
- Double click on layer ► Symbology tab

The **Layer Properties Dialog** regroups all the properties of a layer, and not just the symbology. There are many different tabs here, for example the **Information** tab which usefully gives the metadata of the layer. More information on these tabs can be found in the QGIS documentation.

Within the **Layer Properties Dialog**, it is possible to save the symbology of a layer (colour, line thickness, labels etc).

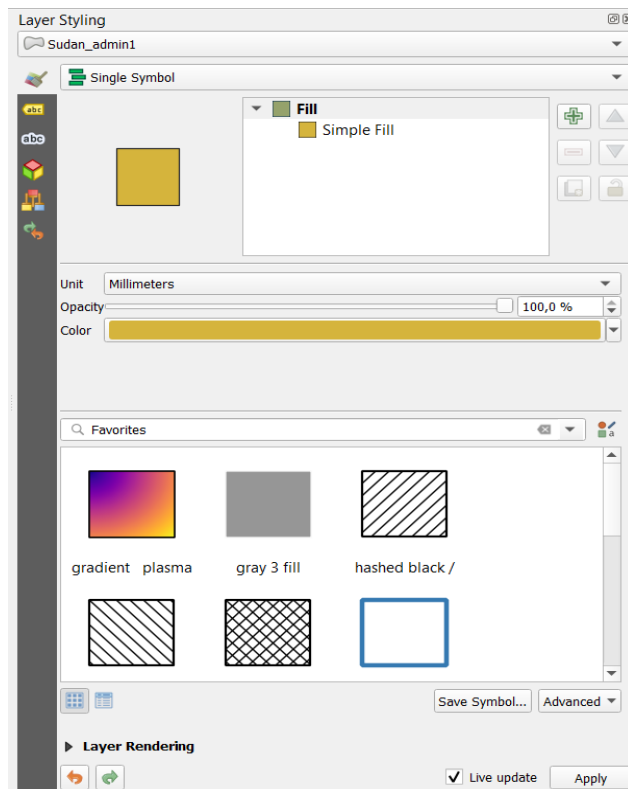


Method 2: Via the **Layers Styling** panel

The **Layer Styling** panel provides a shortcut to the layer styling functionalities of the **Layer Properties Dialog** (e.g. Symbology, Labels), allowing for a quick and easy way to directly visualise changes made to the style of a layer. It does not, however, provide access to all the other properties of a layer, and does not allow you to save the style of a layer.

We added the Layer Styling panel in Section 4, but the **Layer Styling** panel is not visible by default. If it has since disappeared, open it up again:

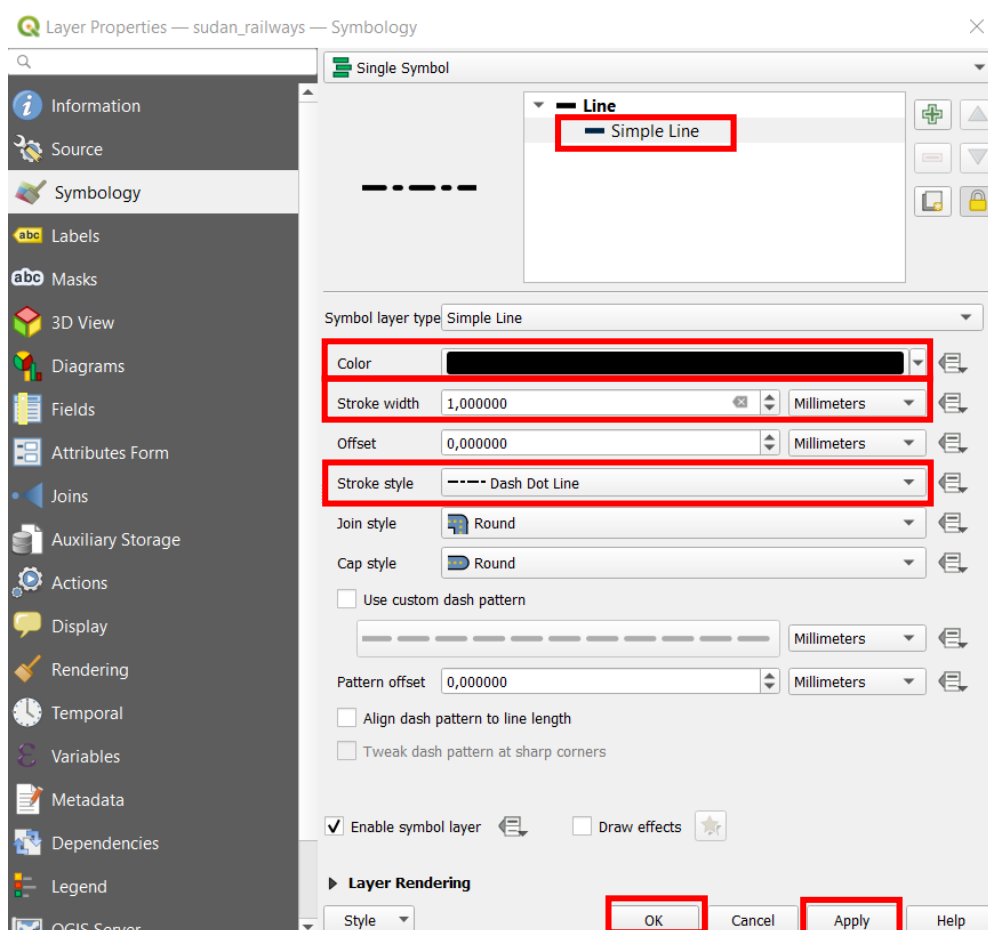
- **MENU View ► Panels ► Layer Styling Panel ► Symbology tab**



- **Change the symbology of the layer `sudan_railways`**

Go back and open the **Layer Properties Dialog** and open the **Properties** tab for the layer `sudan_railways`. Select the following options:

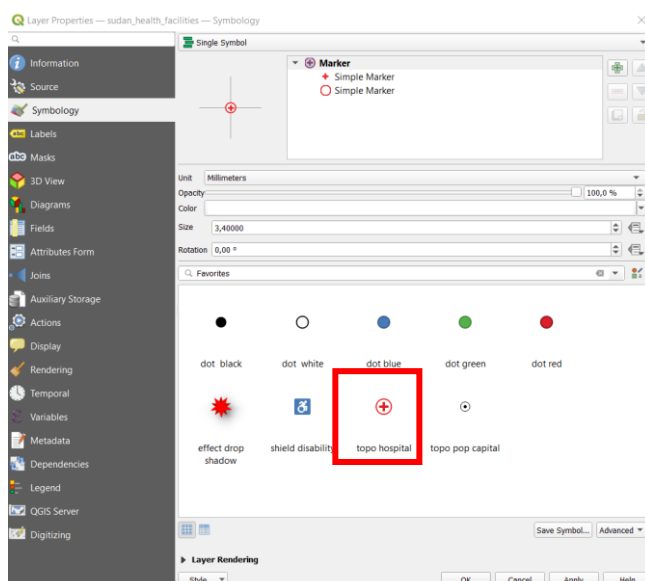
- Click on **Simple line**. Additional options will appear below.
- Click on the **Colour bar** ► **Select new colour** ► **OK**
- Increase **stroke width** (line thickness) to e.g. 1,00
- Change **stroke style** to e.g. Dash Dot Line
- Click on **Apply** to view the changes, and **OK** when you have finished making the changes



- Change the symbology of the layer **sudan_health_facilities**

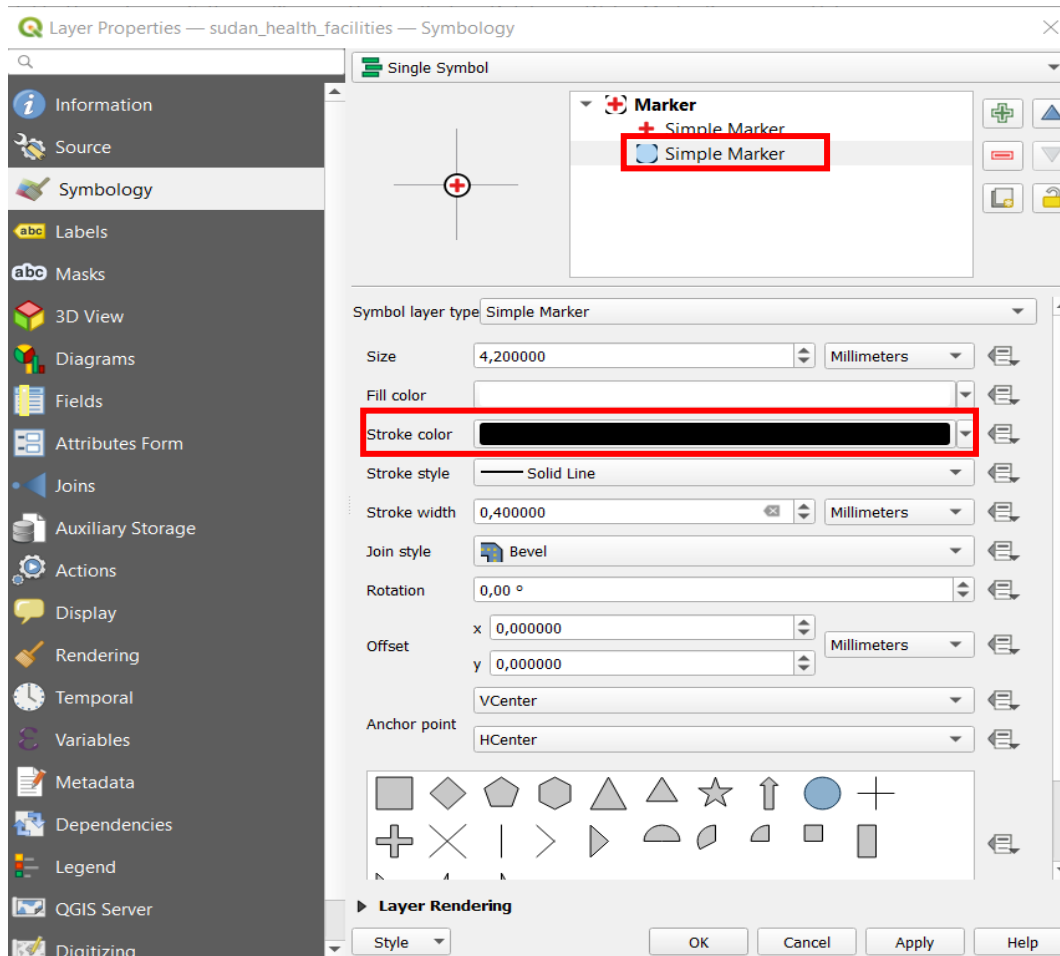
You will see at the bottom of the **Layer Properties Dialog** that there are some styles that are already prepared. Here, we can see that there is a symbol called **topo hospital**.

- Click on the marker **topo hospital** ► **Apply**



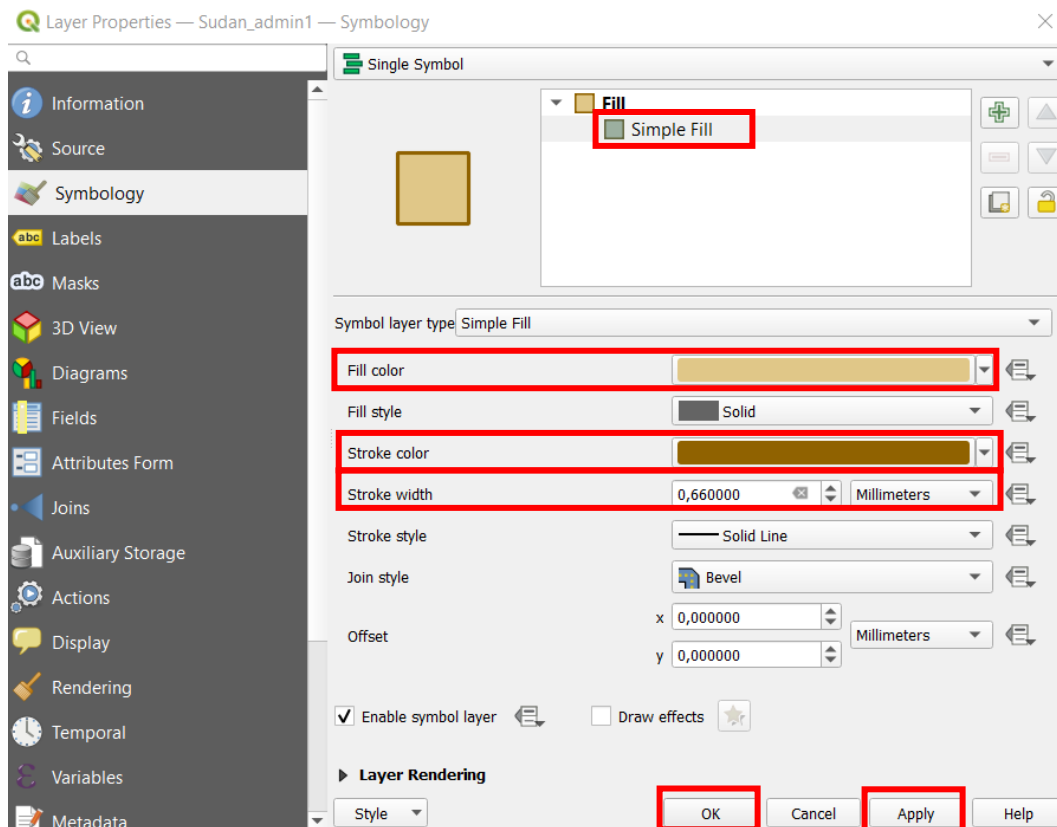
We can see on the map that all the health facilities are now represented by a red cross, although the symbols are quite big.

- Decrease the **Size** of the symbols to 4.2
- Click on the red circle simple marker and change the **Stroke colour** to black
- When you have finished making the changes click on **Apply ► OK**



Alternatively, for vector points, within the **Single Symbol** option, is to use **SVG symbols**. These SVG images can be useful when making a map, to represent e.g. airports, restaurants, schools, banks, hospitals etc.

- Click on the red cross **simple marker** and in the **Symbol Layer Type**, click on **SVG marker**.
- In the bottom right-hand corner, in the SVG images section, look through the icons and choose one to represent the health centres (e.g. there are different types of crosses).
- You can change the size and the colour for this marker.



Vector labels

We will now see how to add labels to a layer.

- **Add labels to the layer Sudan_admin1**

Firstly, open the attribute table of the layer **Sudan_admin1** and identify the name of the Field (column) which provides the name of the column containing the names of each state in Sudan.

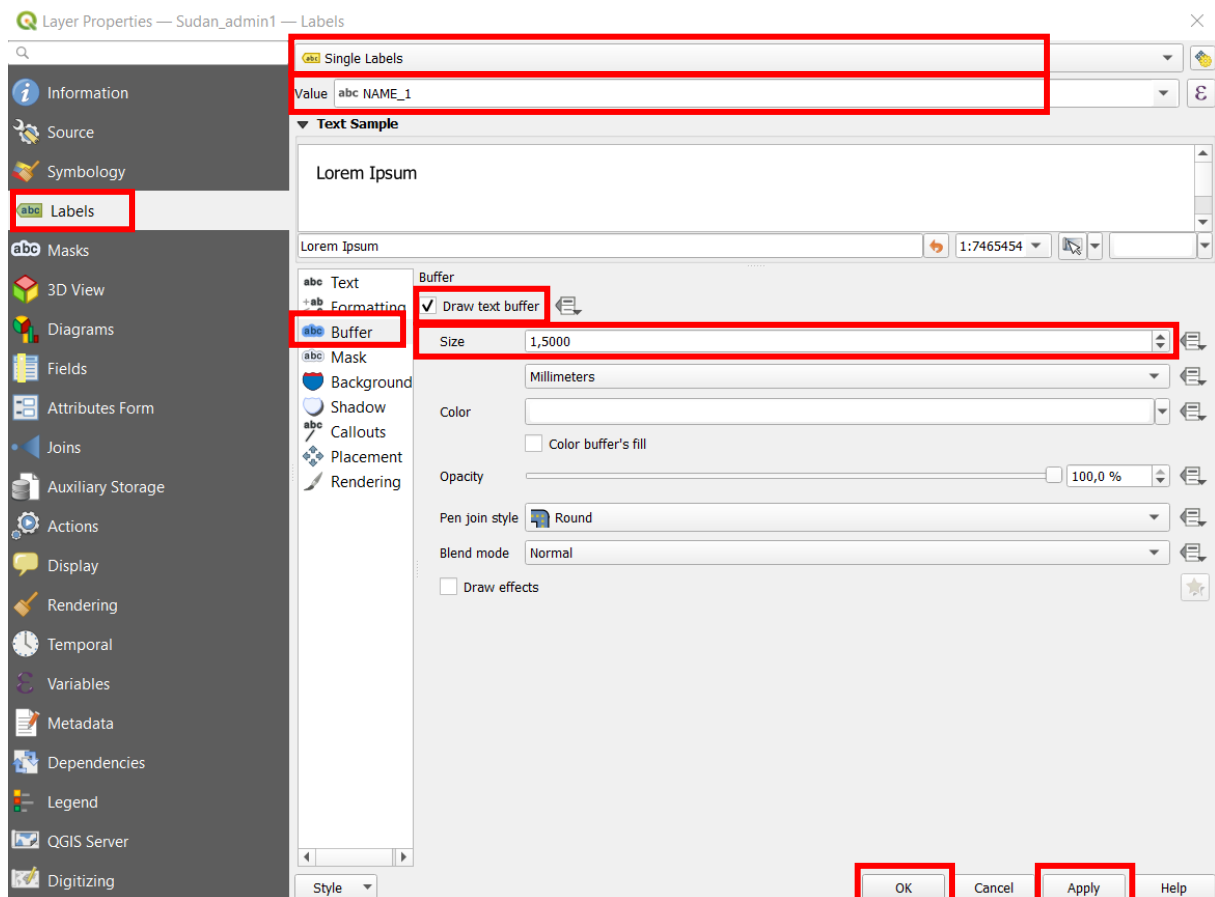
Open again the Layer Properties Dialog for the layer **Sudan_admin1**, but select the Labels tab 

- In place of the **No Labels** option, select **Single Labels**

Under **Value**, click on the dropdown arrow. This provides a list of all the existing different attributes (i.e. Field) of the vector layer, as we saw in the **attribute table**. In the list, select the attribute containing the names of each state in Sudan that you have just identified.

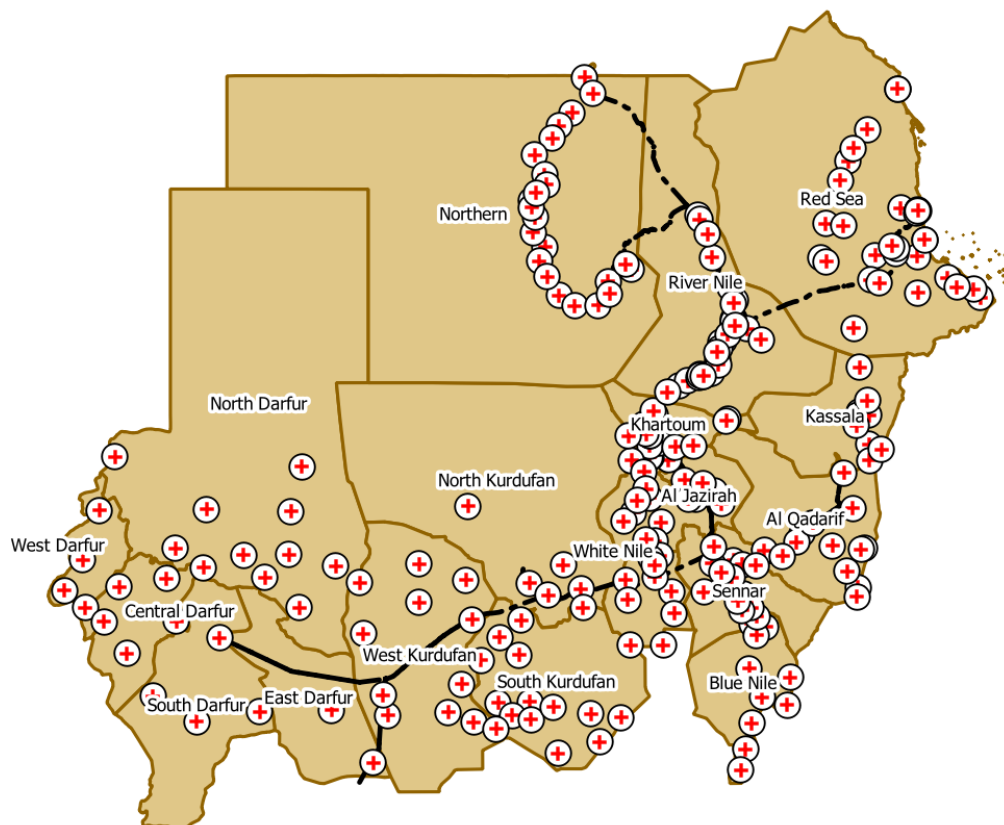
There are many different options for labelling, to format the text and position of the labels. It is also possible to add labels only to certain elements, or to create different rules to have different types of labels to different elements. We will only look at the buffer now, which can help increase the visibility of the labels

- Go to the **Buffer** tab, check **Draw text buffer** and increase the **Size** to **1.5**.
- **Click Apply ► OK**



In the map view, we can now see the names of all the states in Sudan.

Save the project (**MENU Project ► Save**)



It is possible to copy and paste the symbology of one layer to another, however both layers must be of the same data type (e.g. from a vector point layer to another vector point layer).

To do so, in the **Layers** panel, right click on the layer you wish to copy the style from ► **Styles ► Copy Style ► All Style Categories**. It is possible to copy only one part of the layer style (e.g. only the **symbology**, or only the **labels**). Then right click on the layer you wish to add the style to ► **Styles ► Paste Style ► All Style Categories**

Copy the style of the **Sudan_admin1** layer and try to paste it onto the **sudan_railways** layer. It doesn't work, why not?

8. Raster data in QGIS

Adding raster data to QGIS

- Add the file **worldpop_khartoum_buildings.tif**

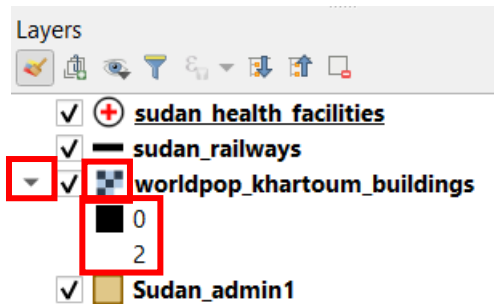
The methods introduced for adding vector data to QGIS can mostly also be used to add raster data.

- The **Data Source Manager** via the Raster tab 
- Via the **Browser panel** (**double click** or **drag and drop** or **right click ► add layer to project**)

This layer contains information on the presence of settlements in Khartoum, both urban and rural. The dataset is freely available online (see Section 3: Data) but has been slightly modified for the purpose of the lesson.

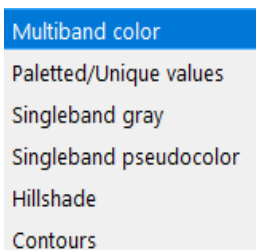
Currently we cannot see the layer very well. Zoom into the layer (**right click ► Zoom to layer**). It is also possible that the **worldpop_khartoum_buildings** layer is now covering the visibility of the **sudan_health_facilities**. If this is the case, change the order of the layers in the **Layers** panel.

Note in the **Layers** panel, the gridded symbol that is used to represent the raster layer. If you click on the little arrow on the left, the symbology of the layer is displayed.



Raster symbology

We can also access the **Layers Properties Dialog** in the same way as for the vector files. The options for symbolising raster data are different than those for vector data.



- **Change the symbology of the layer worldpop_khartoum_buildings**

First, open the Layer Properties Dialog for the **worldpop_khartoum_buildings** layer, and select the following:

- For the **Render type** ► **Paletted/Unique values** ► **Classify**. As the **Color ramp** is **Random colors**, this attributes a random colour to each of the classes in the raster layer – here we have 3 classes (see table).

This table shows the label that corresponds to each raster value.

Raster value	Label
0	Rural
1	Urban
2	Not Built-up

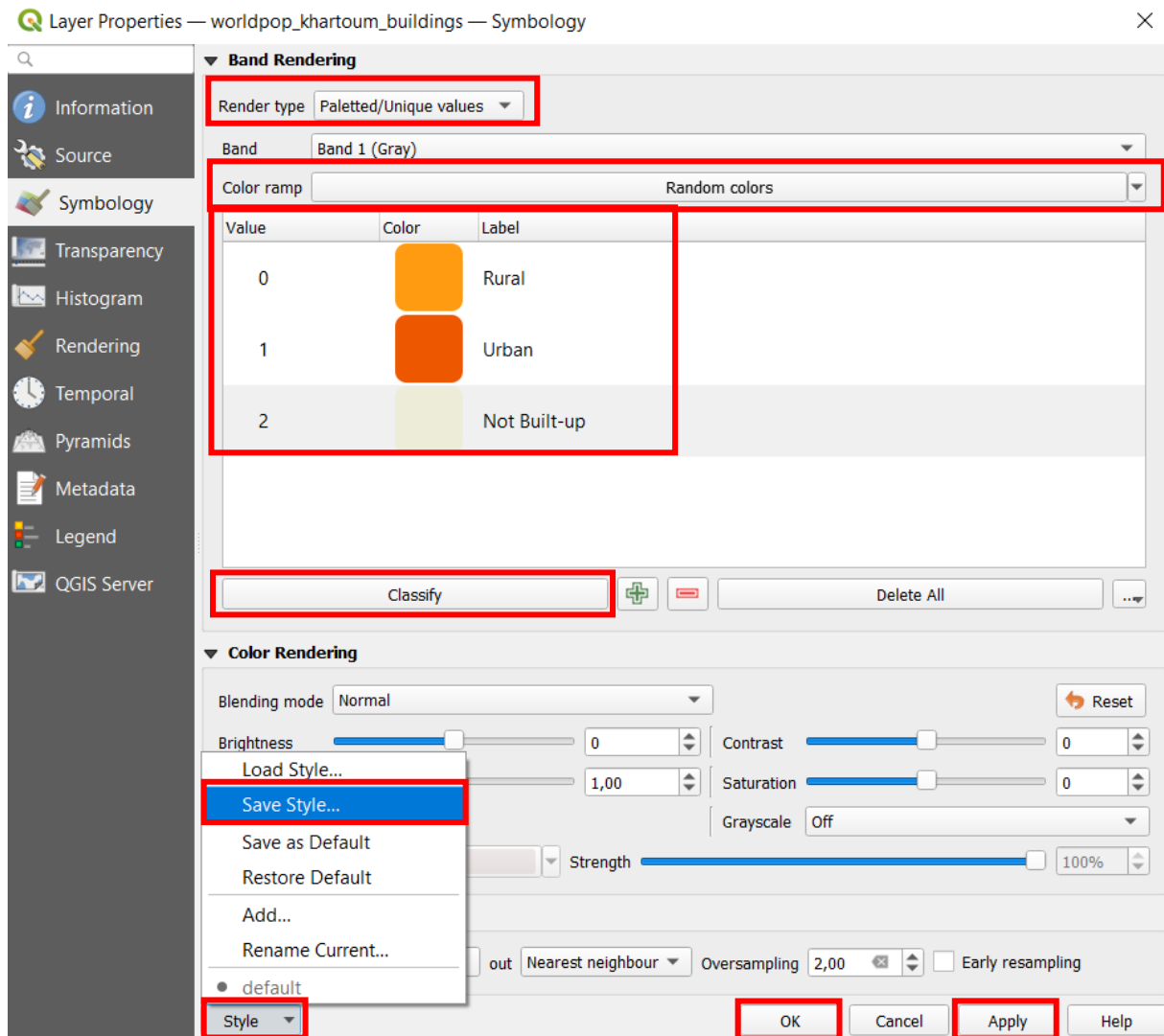
Instead of random colours, we can also select a specific **Colour ramp** (click on the down arrow), or we can interactively choose a colour for each class. This is what we will do here.

- To interactively change a colour, double click on the colour square you would like to change. This opens the **Select Color** window.
- For each of the classes, choose a colour. What colours might be appropriate? Use the table with the labels to help understand what each raster value represents.
- Click on **Apply** to visualise the changes, without needing to close the **Layer Properties Dialog**.

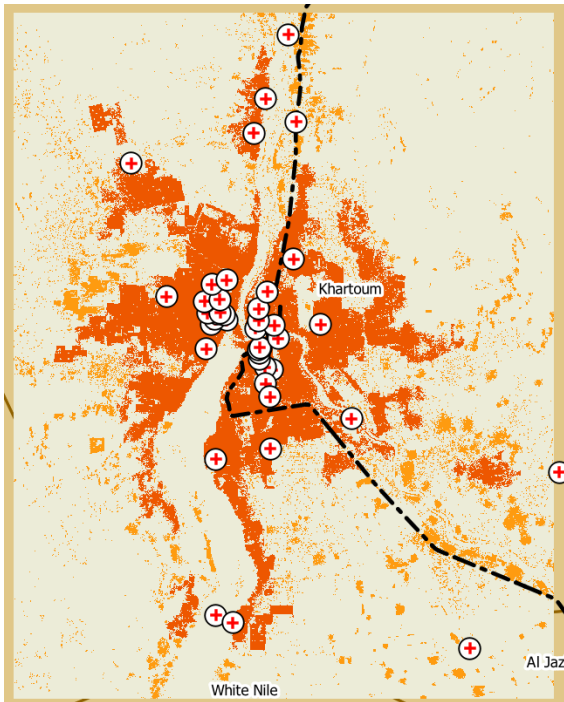
Once you are happy with your choice for the 3 classes, you can also change the Label of the classes to correspond to the table above.

- Double click on each label name to replace with the label names given in the table above. Click on **Apply**

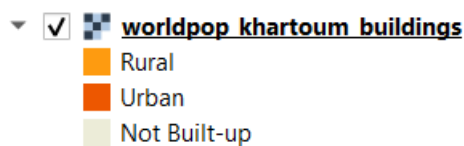
When you are happy with the style of the layer, from the **Style** drop down menu, select **Save Style...** to save the symbology of this layer (i.e., the classes, colours...) as a .qml style file, in the folder where the data are stored. This will allow you to use it in other QGIS projects if needed. Name the file **khartoum_urban**.



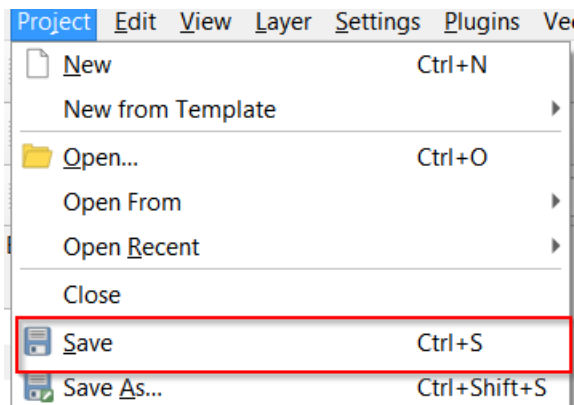
An example of what the map could look like:



In the layers list, if you click on the little arrow to the left of the name of this raster layer, you can now see the raster legend.



Remember to regularly save the project (**MENU Project ► Save**)



9. Composing a map layout

What makes a good map?

The aim of a map is to communicate information. Often, maps are created to present information to people that do not have a background in GIS. The process of making a map, therefore, is the process of arranging the elements of a map in a way that, with very few words, any person can understand what the map is about.

There are certain elements that are necessary when producing a map.

- **Title** – with the theme, and can include the location of the map if this is useful

- **Map body** – The most important part of the layout, as it contains the map information. It should be as big as possible
- **Legend** – this explains all the symbols on the map, i.e. how to understand the data in the map. It should be complete, clear and easy to understand
- **Scale-bar** – represents the ratio of a distance on the map to the actual distance in the real world. It is necessary to understand the area covered by the map, and is especially useful when changing the size of the map.
- **North arrow**
- **Sources of the data used to make the map, and their date**

Other optional elements can be added to a map, e.g. a **graticule**, an **overview**, the projection system, the software used, author, logo ... etc. Together, these elements help the map reader to interpret the information shown on the map.

Map layout in QGIS

In QGIS, the **Print layout** is used to prepare maps for printing or exporting to documents. The **Layout manager** is used to manage your print layouts (you can make more than one). You can access the **Layout manager** via

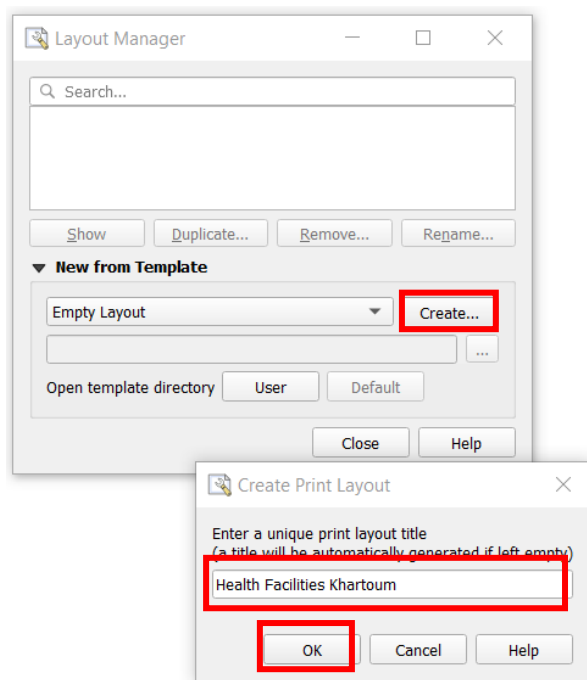
- **MENU Project ► Layout Manager**

- Or in the **Project toolbar** ► 

Within the Layout manager you can, as the name suggests, manage your layouts. Each layout must have a unique name. If you have at least one layout in the project, these buttons will become available. These can be very useful, e.g. if you would like to make a second map only slightly different to the first, the **Duplicate** option can be very useful.



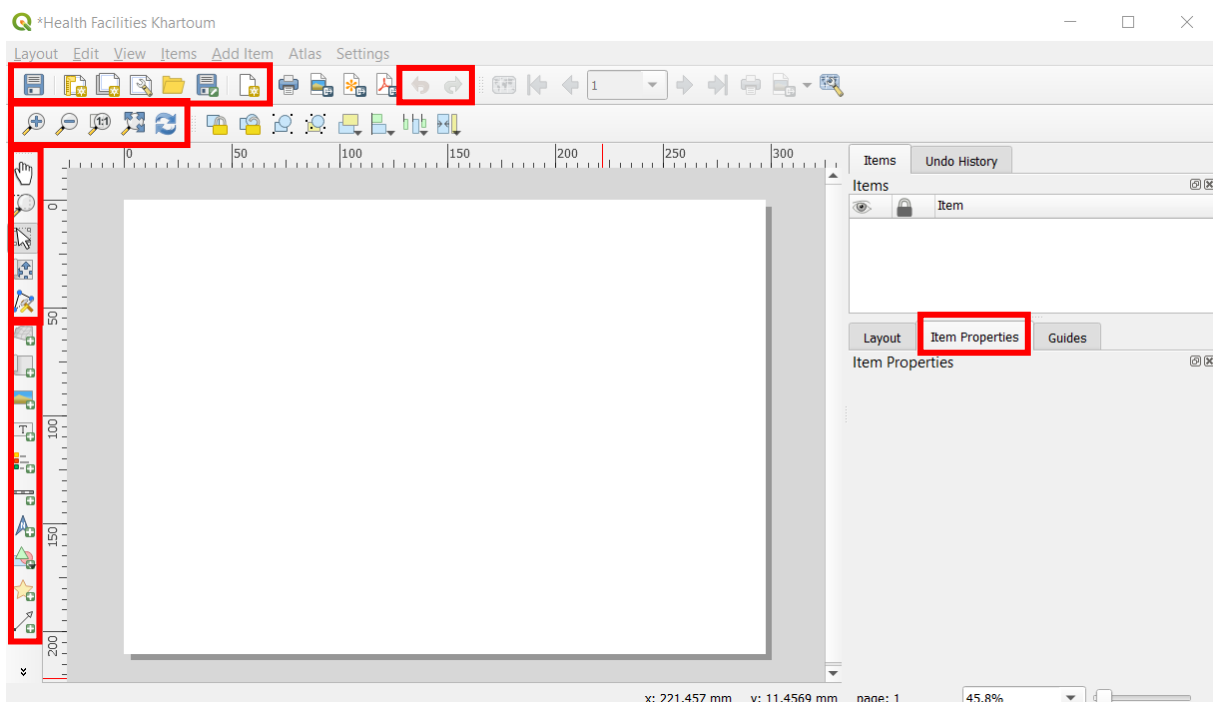
Click on **Create** and on the window that pops up (Create Print Layout), give a useful name to the map such as **“Health Facilities Khartoum”** and click on OK.



This launches the **Print Layout** window.

The Toolbox on the left-hand side provides options to add elements to the layout e.g. adding a map, scalebar etc., or to move about in the map layout or move element in the layout. In the toolbar on the top are different options for managing map layouts, zooming in and out, etc. You can also undo and redo manipulations (e.g. to go back a step if you make an error).

The Item Properties will enable you to change the properties of the different elements you add to the layout (e.g. for the map itself, the scale bar, legend, etc). Right now, there are no elements yet.



Producing a simple map

We will use the **Print Layout** to create a simple map of health facilities in Khartoum.

- **Add a map in the Print Layout**

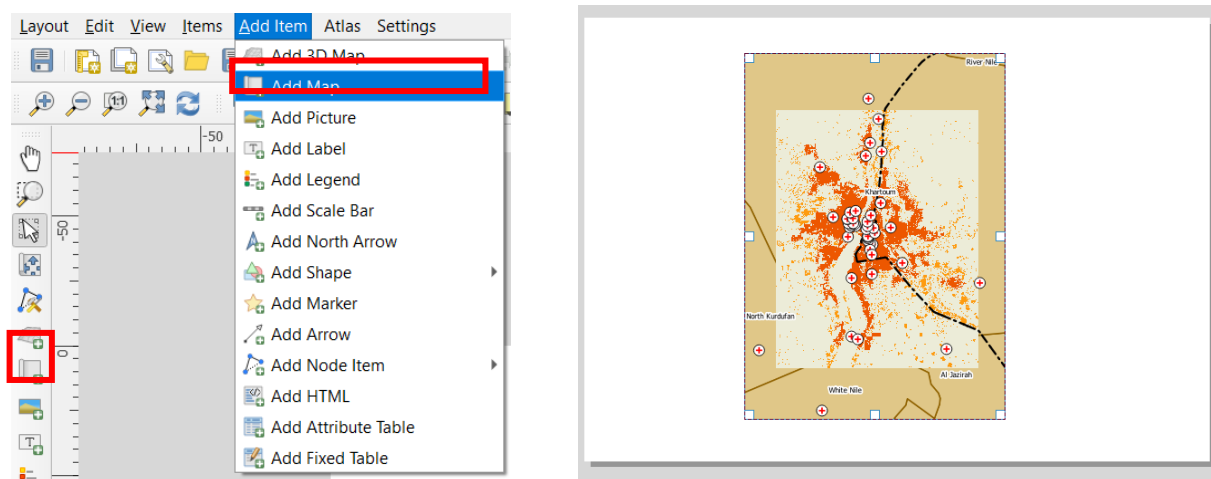
To add a map in the **Print Layout**:

- **Use the Add Map symbol** 

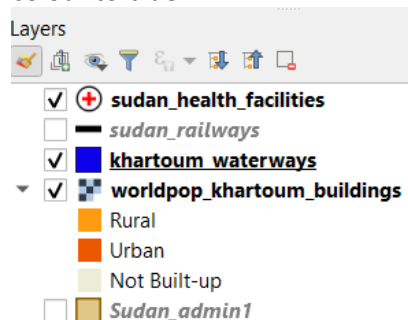
Or


- **Add Item ► Add Map**

Then draw a rectangle on the display to load the data layer. Make sure to leave some space for the other elements to be added to the layout. By default, all the active layers in the **Layer Panel** (in the main QGIS window) will appear in the **Map** element.

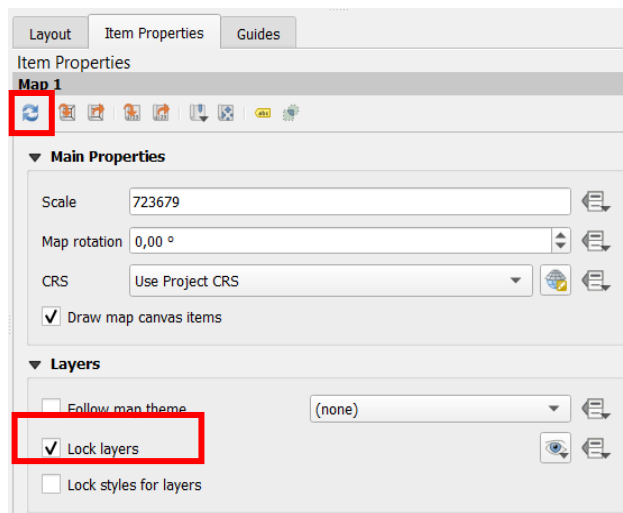




Go back to the main QGIS window and uncheck the layers **sudan_admin1** and **sudan_railways**. Add the shapefile **khartoum_waterways.shp** to the **Layers panel** and make sure it is above the **worldpop_khartoum_buildings** layer in the list of layers. Go into the **Layer Properties** and change the colour to blue.



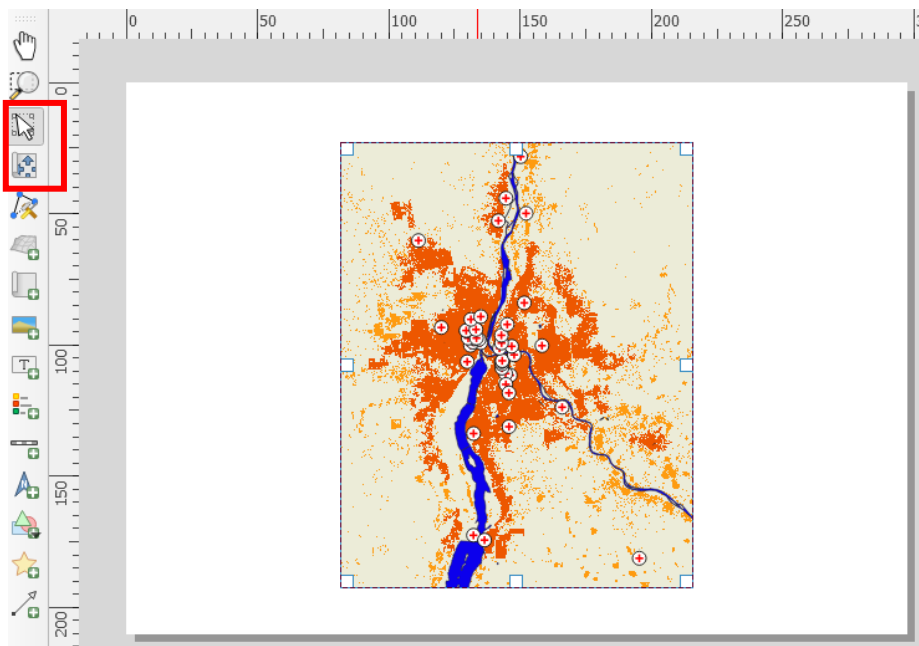
Go back to the **Print Layout**, select the map element, and click on **Update Map Properties** icon  (in the **Item Properties**). What do you notice?

To stop the layers in the **Print Layout** from changing depending on the active layers in the **Layers panel** (main QGIS window), we have to **Lock layers**.



- The **Move Item Content** icon  enables you to move the map within the box, zoom in and out (using CTRL + mouse zoom)
- The **Select / Move item** icon  enables you to move and reshape the box, or other items in the print composer

Use these tools to reshape the map in the print composer.



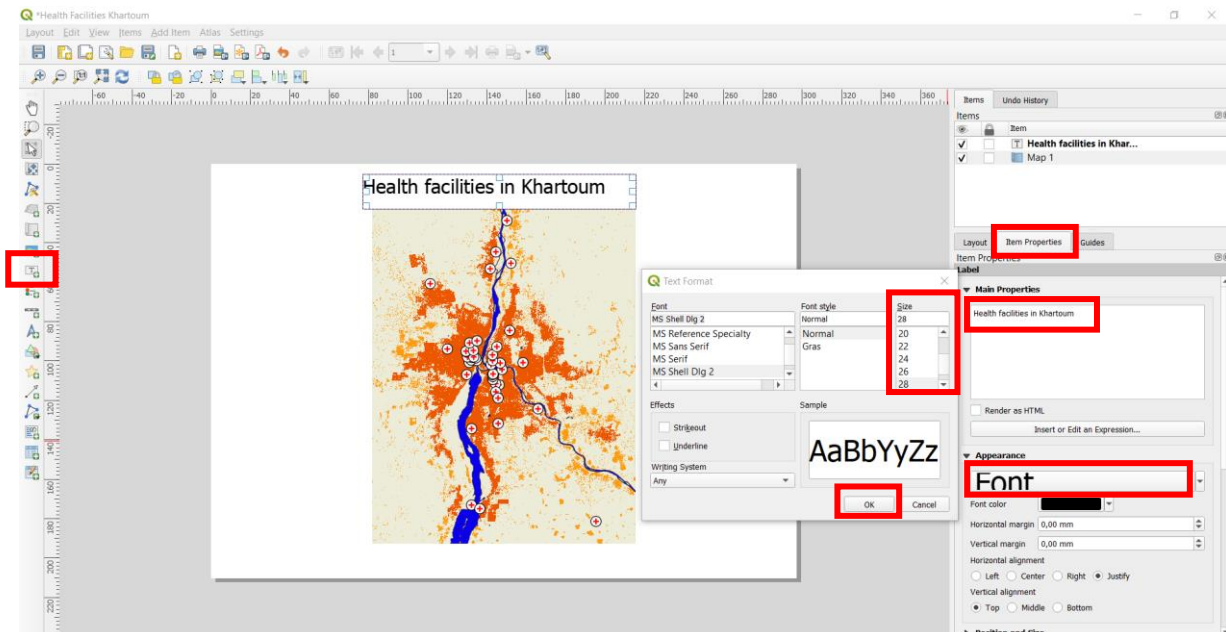
- **Add a title to the layout**

To add a title to the layout, use the **Add Label** option

- **Add Item ► Add Label ► Draw a rectangle on the display to load the text box**

By doing this, the area that map title will appear is loaded but not the title itself. For this we need to type the desired title in the **Map Properties** section after we have selected the title Item. Type a title e.g. **Health facilities in Khartoum**

For the title, we can change the font size by clicking on the **Appearance - Font** options and increasing the size.



- **Add a legend to the layout**

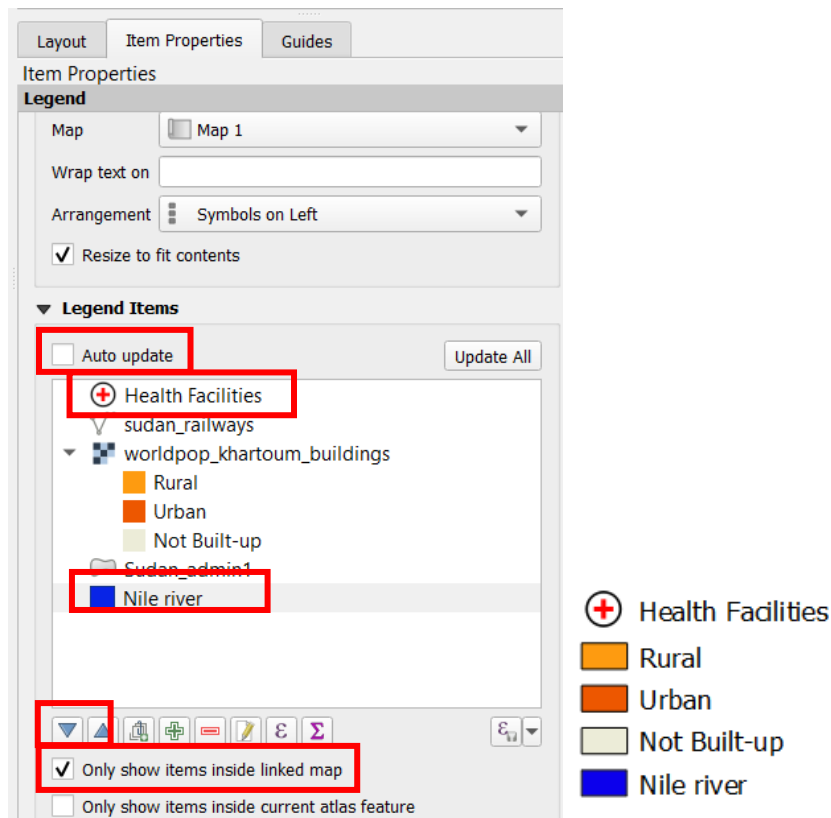
Afterwards, we can add a legend by:

- **Add Item ► Add Legend ► Draw a rectangle on the display to load the legend**

Automatically, all the layers that are present in the QGIS project will appear, whether or not they are visible. In the legend, you should only represent the layers that are visibly present in the map.

In the **Items** section (upper right corner) click on the on **<Legend>**. Then below on **Item Properties**. There are different sections within the **Item Properties**. In the **Main Properties** it is possible to name the legend and choose which map the legend corresponds to (in this case we only have one map). In the **Legend Items** section, we can manage which items are show in the final legend.

- Uncheck **Auto-update**, to enable you to manually modify the legend elements.
- Right click on the title **worldpop_khartoum_buildings** and click on **hidden**, so that it does not appear
- Check **only show items inside linked map** this means that only items in the map itself will be shown
- It is possible to change the order in which the legend items are shown, using the up and down arrows. Put the **khartoum_waterways** layer at the bottom of the legend.
- By default, the name of the layers will be the same as in the **Layers panel**, however these are rarely suitable for the production of a professional looking map. Double click on the title **sudan_health_facilities** to rename it as something more informative (e.g. **Health Facilities**). When you have finished renaming, click on the back arrow to return to the **Legend Items**. Do the same for the **khartoum_waterways** layer (e.g. **Nile river**).
- Move the legend to a suitable location in the layout. Usually, the legend is found to the right, to the left, or under the main map.



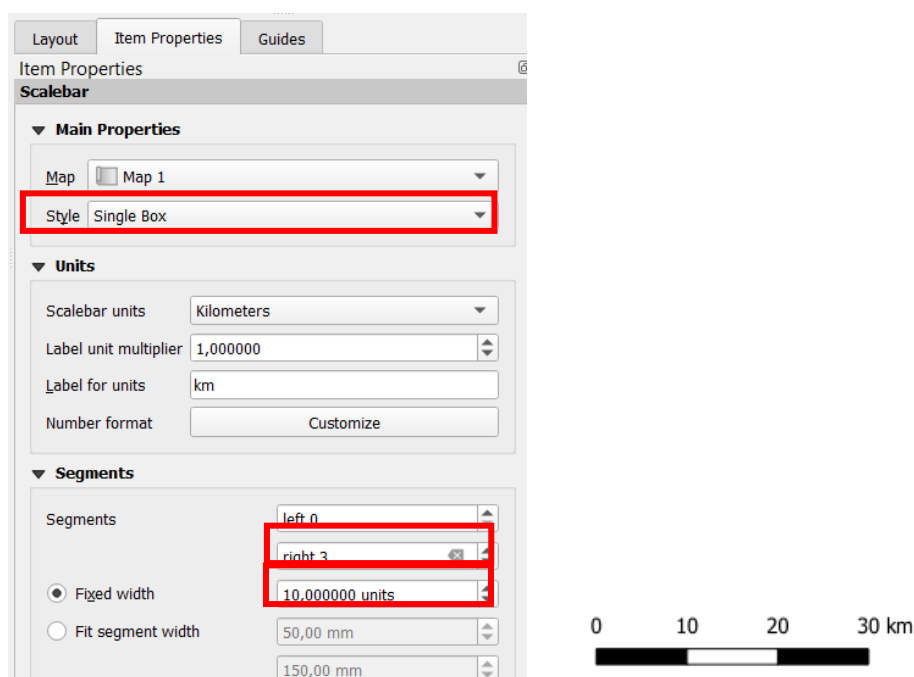
- **Add a scalebar to the layout**

We may add a scale bar by going to the respective option in the *Add Item* section:

- **Add Item ► Scale Bar ► Draw a rectangle on the display to load the scale bar**

Usually, the **Scale Bar** is placed under the main map. QGIS tries to determine the best properties for the scalebar, however it often needs to be adapted. Change the number of **Segments** to the right as **3**, and define a **Fixed Width** of 10km.

By default the **Style** is a **Single Box**, but other options are available if you wish to have a different style.



- **Add a north arrow to the layout**

We can similarly add a north arrow to the by going to the respective option in the *Add Item* section as previously:

- **Add Item ► North arrow ► Draw a rectangle on the display to load the north arrow**

There is a default North arrow, but if you wish, you can choose a different north arrow from the SVG icons proposed in the **Item Properties**. By default, a map is orientated with North towards the top. If the north orientation of the map is not towards the top, it is necessary to link the orientation of the North arrow to the orientation of the map (**Item Properties** in section **Image Rotation ► Sync with map**). In this case, the map is indeed oriented North towards the top.

- **Add the data sources (and date)**

It is good practice to add the sources of the data used in the map. As with the title, this can be added using the **Add Label** option.

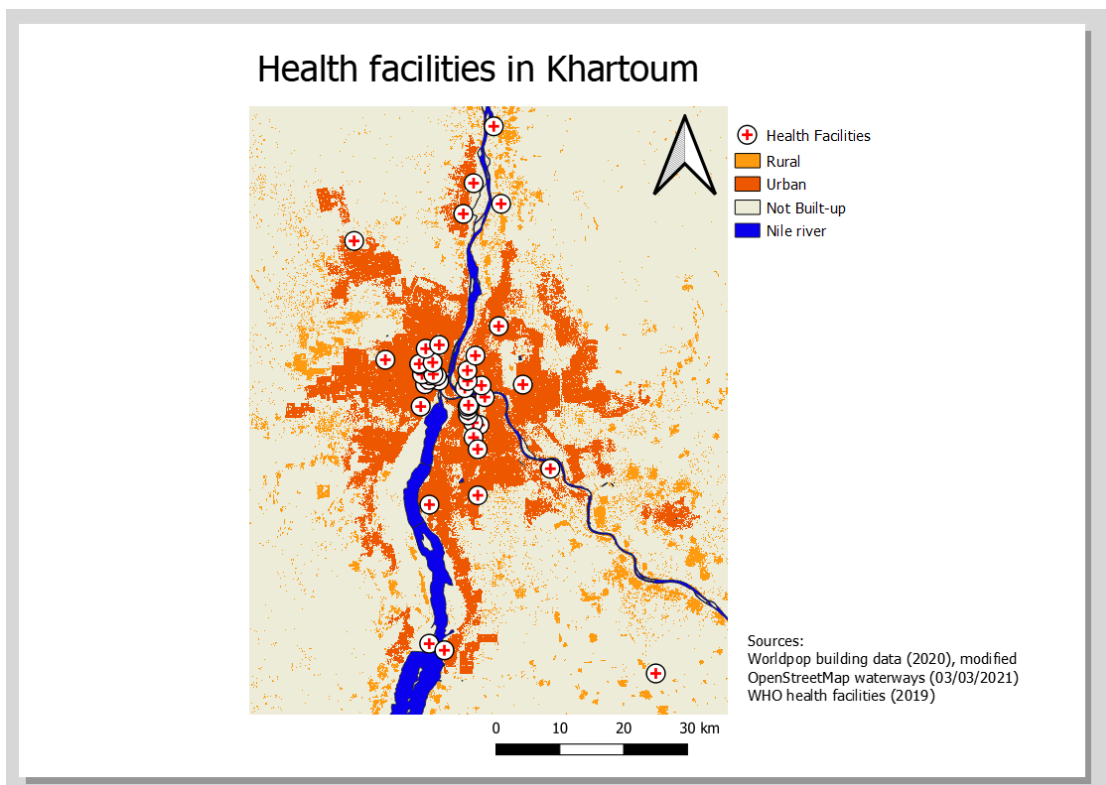
- **Add Item ► Add Label ► Draw a rectangle on the display to load the text box**

Here we use multiple data sources, it could look something like this:

Sources:

Worldpop building data (2020), modified
OpenStreetMap waterways (03/03/2021)
WHO health facilities (2019)

You may need to move around the map elements on the layout.



- **Export the map as an image**

When the map is finished, we can export the map as an image by going to **MENU Layout ► Export as image**. Select the path for the file to be saved and click **Save** on the window that pops up. Do the same again but as a PDF **MENU Layout ► Export as PDF**

In the files on your computer, navigate to the two files, open both of them and zoom in very far. What difference do you notice between the PDF and the image?

Remember to regularly save the project (**MENU Project ► Save**)

Congratulations, you have reached the end of the introductory tutorial on QGIS!

If there is still time left, or if you wish to further develop your introductory skills in QGIS, Section 10 presents some additional exercises, introducing a number of other useful tools in QGIS.

10. Additional Exercises

Installing plugins

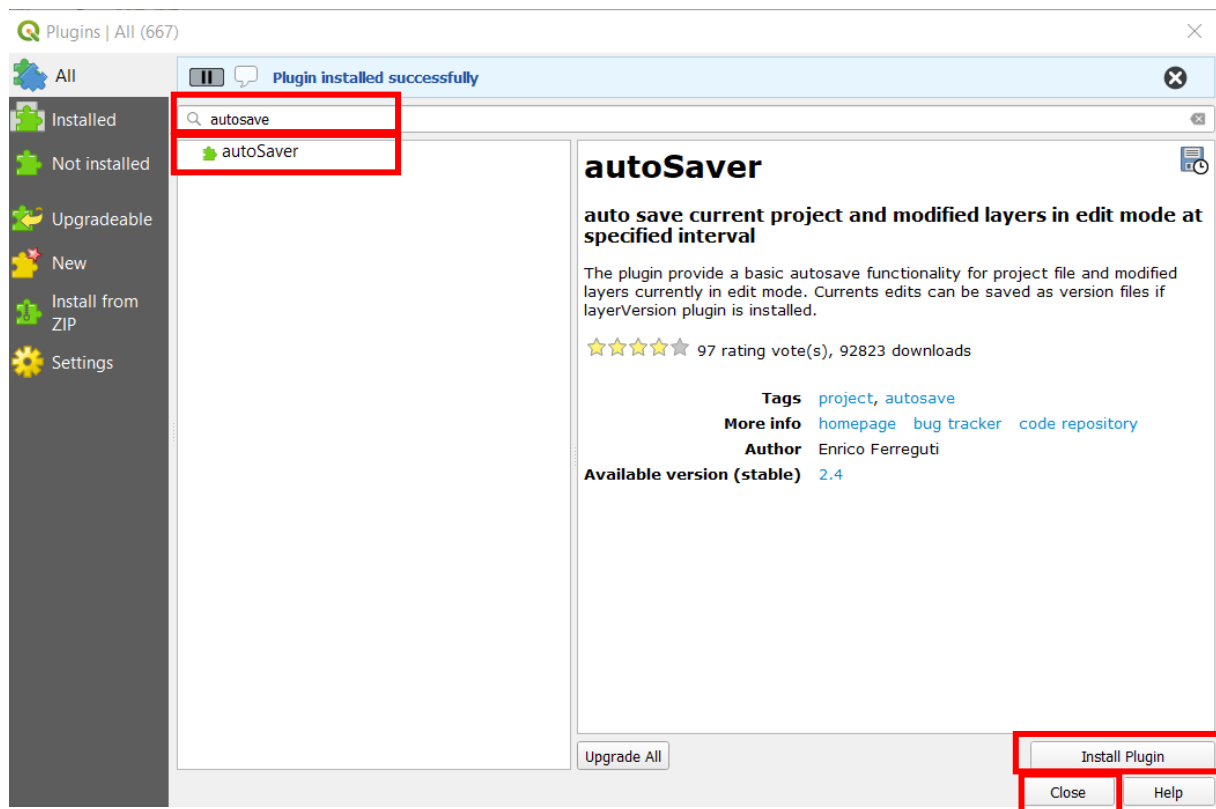
QGIS works with a system based on Plugins / Extensions. This allows you to easily add extra functionalities to the software.

To open the Plugin window **MENU Plugins ► Manage and Install Plugins**. Here you can manage, install and uninstall plugins.


- **Install the autoSaver plugin**

The autoSaver plugin provides a way to regularly and automatically save your QGIS project. This can be very handy if you have a tendency to forget to regularly save your work.

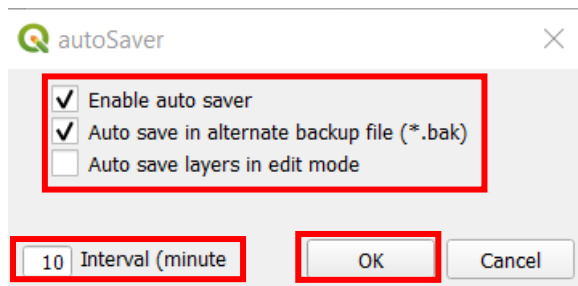
In the **Plugins window**, type 'autoSaver' in the search bar. Click on 'autoSaver' to select it. The right hand side of the window explains what the plugin does. Click on **Install Plugin**. Once done, close the **Plugins window**.



The plugin can be found in two ways:

- **MENU Plugins ► autoSaver ► autosave current project**
- If the **Plugins toolbar** is activated, with this icon 

Open the autoSaver plugin and in the window that pops up, select Enable auto saver. Select the Interval to how regularly you would like your QGIS project to be saved. You can also choose whether to autosave layers in edit mode.



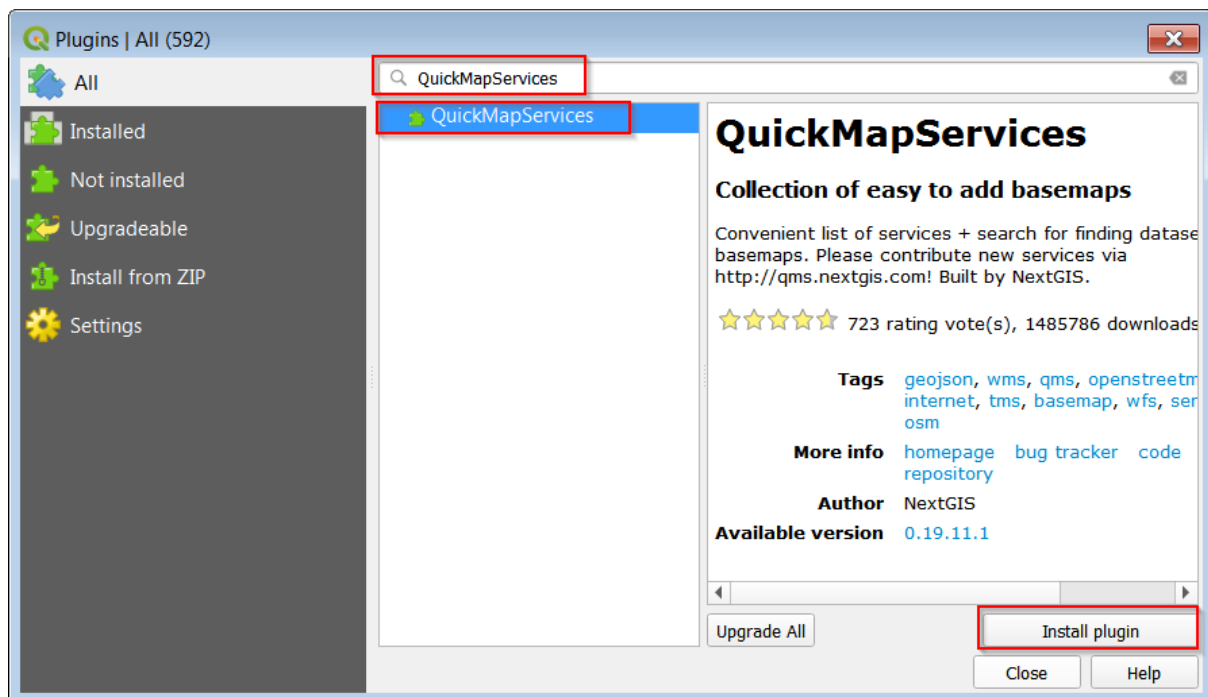
Displaying a basemap

- **Display a basemap: 1/ Install the QuickMapServices plugin**

(Display a basemap only if you have an internet connection)

Install the QuickMapServices plugin: [MENU Plugins ► Manage and Install Plugins](#)

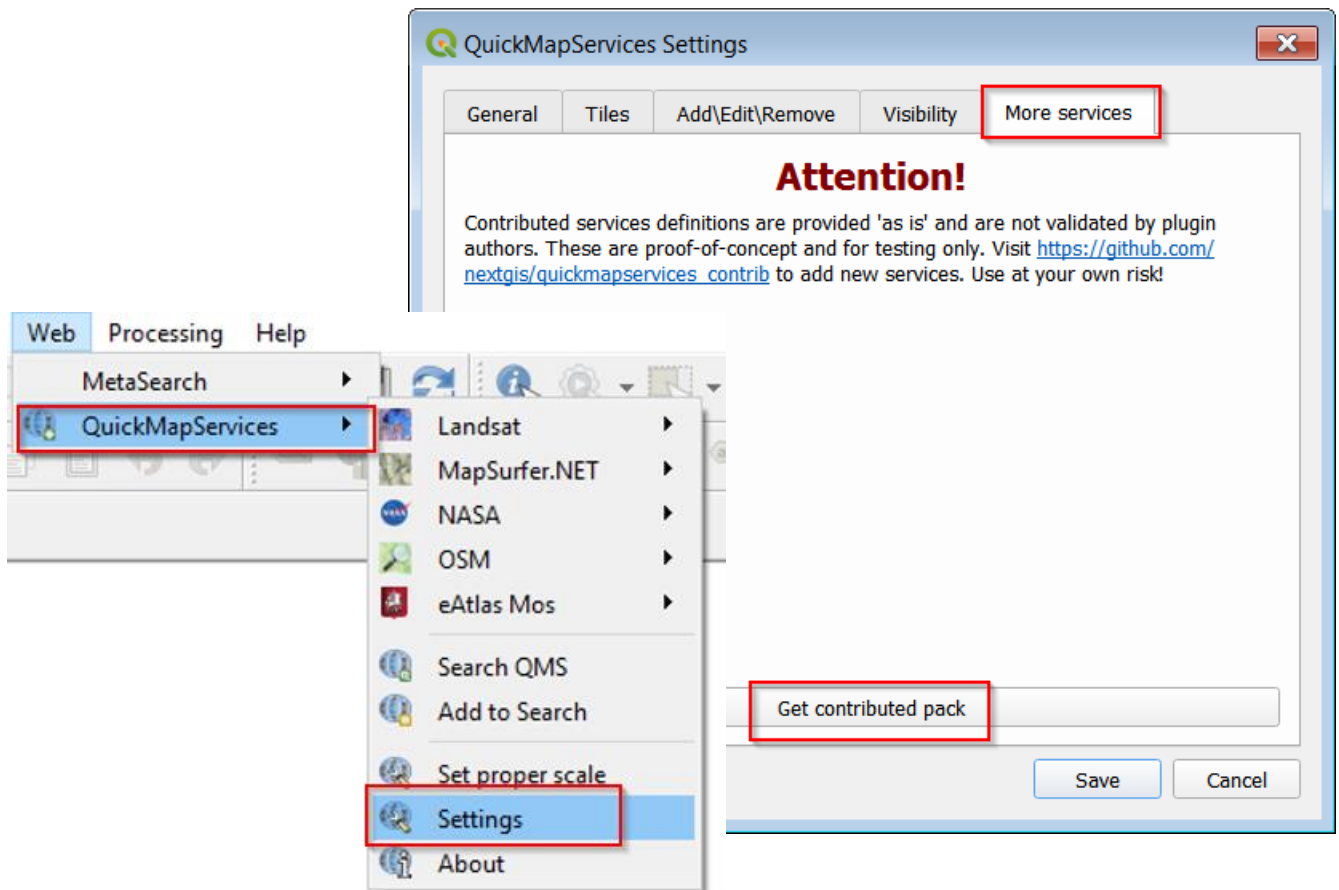
In the [Plugins window](#), type 'QuickMapServices' in the search bar. Click on 'QuickMapServices' to select it and then click on [Install Plugin](#). Once done, close the [Plugins window](#).



- **Display a basemap: 2/ Add contributed pack to QuickMapService**

Click on [MENU Web ► QuickMapServices ► Settings](#)

In the [QuickMapServices Settings window](#), select the [More services](#) tab and click on [Get contributed pack](#).





In the window that pops up ('Last version of contrib pack was downloaded!'), click **OK**. Click **Save** to close the **QuickMapServices Settings window**.

This provides you with many different types of base map layers for visualisation.

- **Display a basemap: 3/ Add satellite imagery as a basemap**

Add satellite imagery as a basemap (**MENU Web ► QuickMapServices ► Google ► Google Satellite**).

Add OpenStreetMap as a basemap (**MENU Web ► QuickMapServices ► OSM ► OSM Standard**).

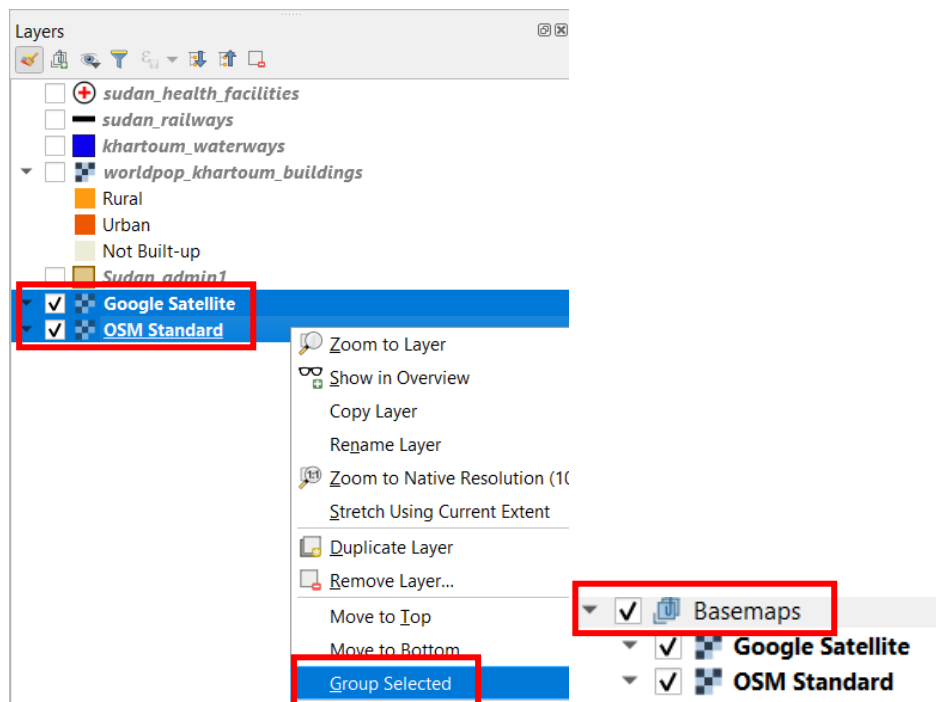
Zoom in and out , and pan  to explore the area. Uncheck the layers you do not wish to visualise while doing so. Can you find the area in which you live in Khartoum?

Grouping data layers

To better organise data layers in the **Layers** panel, it is possible to create **Groups**. There are several ways to create a group.

- Click on the **Add Group** icon in the **Layers** panel, then add (drag and drop) the layers you wish to have in the group
- Right click in the empty space below the layers list ► **Add Group** then add (drag and drop) the layers you wish to have in the group
- Select the layers you wish to group, and click **Group Selected**

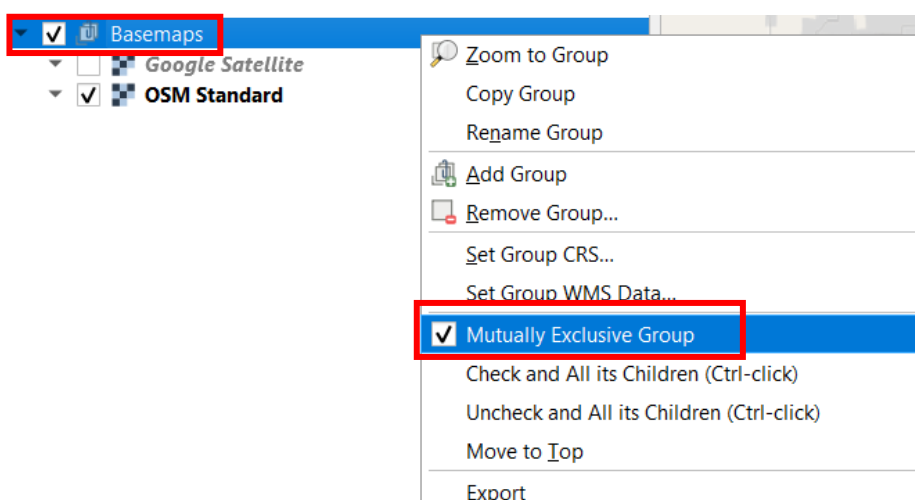
Uncheck all the data layers except for the two basemaps **OSM Standard** and **Google Satellite**, and choose one of these methods to group them together. Rename the group with a useful title (e.g. **Basemaps**).




Uncheck the tick box for **Basemaps**. What happens in the map view?

This allows you to check or uncheck all the layers in the group in one go. You can also add the condition to the group to be **mutually exclusive**. This means that if one layer in the group is visible, the others will automatically not be. In the case of our **Basemap** group, this is very useful as we cannot visualise both basemaps at the same time.

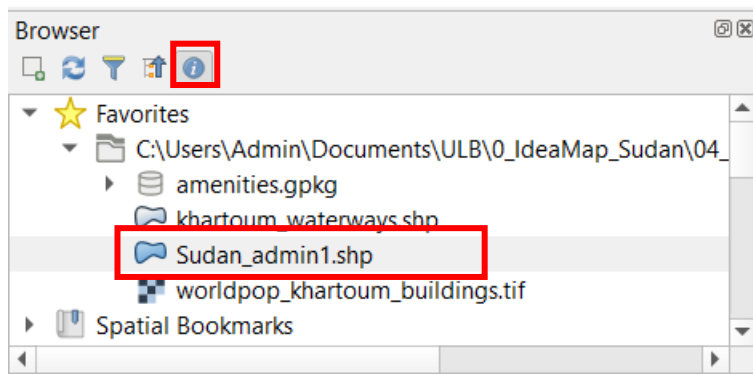
Right click on the group name and select **Mutually Exclusive Group**. What happens when you check the basemap that is not checked?



Using the Properties Widget in the Browser panel

In the Browser panel, you can find the **Properties Widget** can be used to show useful information about specific layers, and can be enabled or disabled using the icon .

Select a file in the Browser panel, e.g. **Sudan_admin1.shp** and enable the **Properties Widget**.



A new widget opens up with three tabs: **Metadata**, **Preview**, **Attributes**.

The **Metadata** tab, as the name suggest, shows the accessible **Metadata** for the selected layer in the **Browser panel** e.g. geometry type, coordinate reference system... etc. and also the different fields (columns of the attribute table) and the properties of each field

Metadata
Preview
Attributes

Information from provider

Name	Sudan_admin1.shp
Path	C:\Users\Admin\Documents\ULB\0_IdeaMap_Sudan\04_Online_PreTraining\IntroQGIS\Lesson2_Data\Sudan_admin1.shp
Storage	ESRI Shapefile
Comment	
Encoding	UTF-8
Geometry	Polygon (MultiPolygon)
CRS	EPSG:4326 - WGS 84 - Geographic
Extent	21.8389491999999983,8.6791191100000002 : 38.8493041999999988,23.1451473199999995
Unit	degrees
Feature count	18

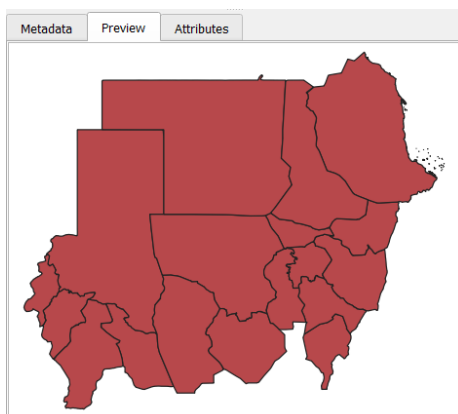
Metadata
Preview
Attributes

Fields

Count 10

Field	Type	Length	P
GID_0	String	80	0
NAME_0	String	80	0
GID_1	String	80	0
NAME_1	String	80	0
VARNAME_1	String	110	0
NL_NAME_1	String	80	0
TYPE_1	String	80	0
ENGTYPE_1	String	80	0
CC_1	String	80	0
HASC_1	String	80	0

The **Preview** tab provides a preview, for spatial data, of how the data would look if added to the QGIS project. (this does not work for non-spatial data)



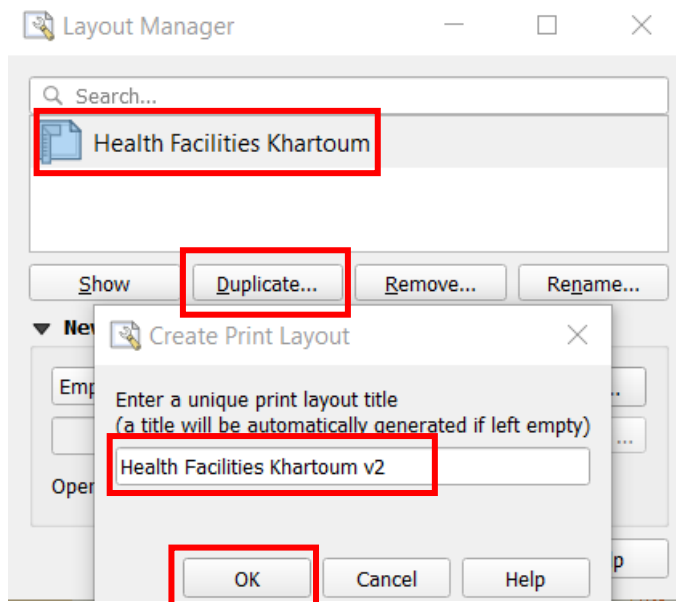
The **Attributes** tab provides a preview of the attribute table for vector data.

Metadata		Preview	Attributes	
GID_0	NAME_0	GID_1	NAME_1	
SDN	Sudan	SDN.1_1	Al Jazirah	Gezira
SDN	Sudan	SDN.2_1	Al Qadarif	Gedarif Gadarif Gedaref Ge
SDN	Sudan	SDN.3_1	Blue Nile	An Nīl al Azraq Nil Bleu Nilc
SDN	Sudan	SDN.4_1	Central Darfur	Zalingei
SDN	Sudan	SDN.5_1	East Darfur	NULL
SDN	Sudan	SDN.6_1	Kassala	Cassala Kessala
SDN	Sudan	SDN.7_1	Khartoum	Al Kharṭūm Al Khurṭūm Car
SDN	Sudan	SDN.8_1	North Darfur	Dārfūr ash Shamālīyah Sha
SDN	Sudan	SDN.9_1	North Kurdufan	Kurdufān ash Shamālīyah Sl
SDN	Sudan	SDN.10_1	Northern	Ash Shamālī Ash Shamālīyah
SDN	Sudan	SDN.11_1	Red Sea	Baḥr al Aḥmar Mar Rojo Ma
SDN	Sudan	SDN.12_1	River Nile	an Nīl, Nahr an Nīl Nīl Nile
SDN	Sudan	SDN.13_1	Sennar	Sinnar
SDN	Sudan	SDN.14_1	South Darfur	Dārfūr al Janūbīyah Janūb I

Additional features of the map layout

For this exercise, please open the **Layout Manager**, click on the title of the map layout we created earlier, click on **Duplicate** ► give a different name to the new print layout (e.g. **Health Facilities Khartoum v2**) ► **OK**


This will create a new map layout, identical to the one we created earlier, and allows us to make changes to the new copy, while keeping a copy of the original map created.

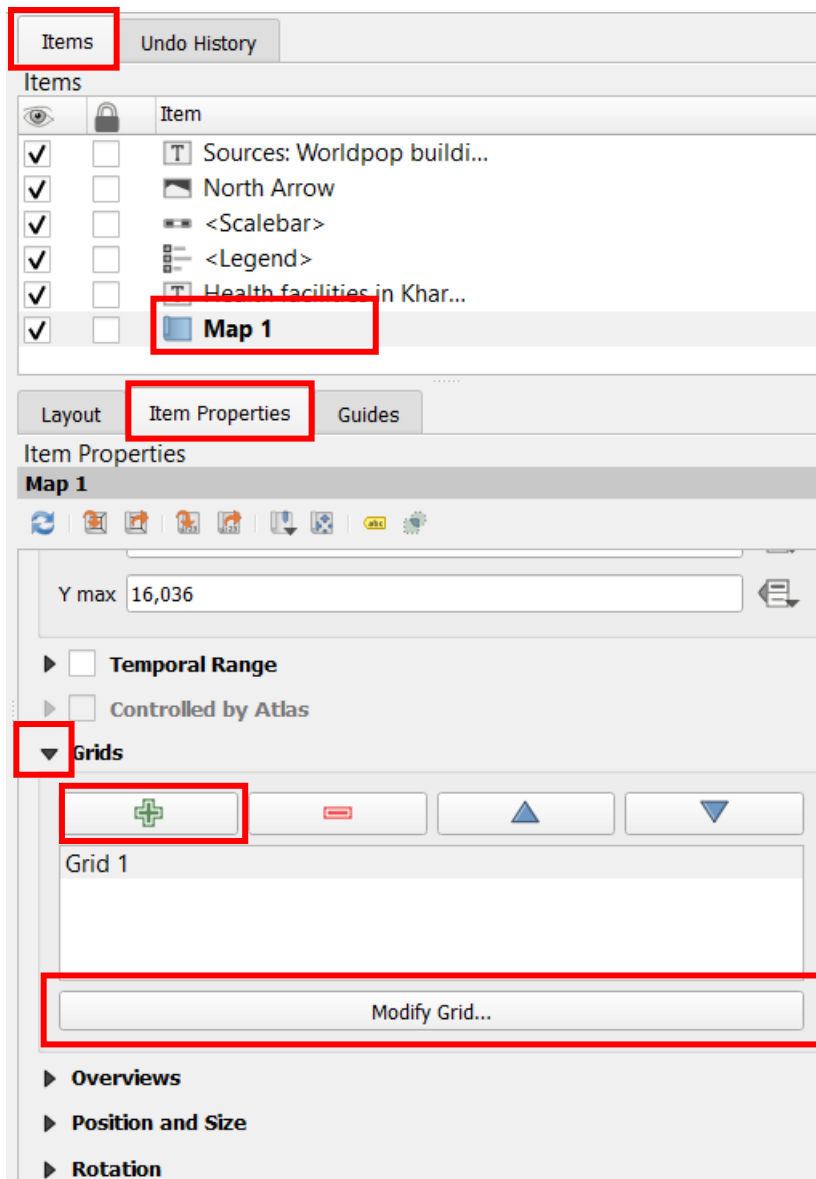


Adding a graticule (grid)

A graticule is a network of lines, or points, designed to be used as a reference to make it easier for the reader to orient themselves.

Now that the new map composer has been created,

In the items list, click on the map item (Map 1) ► **Item properties** ► Scroll down until the section **Grids** and click on the little arrow to open the section ► click on the green cross  to add a grid ► click on **Modify Grid**

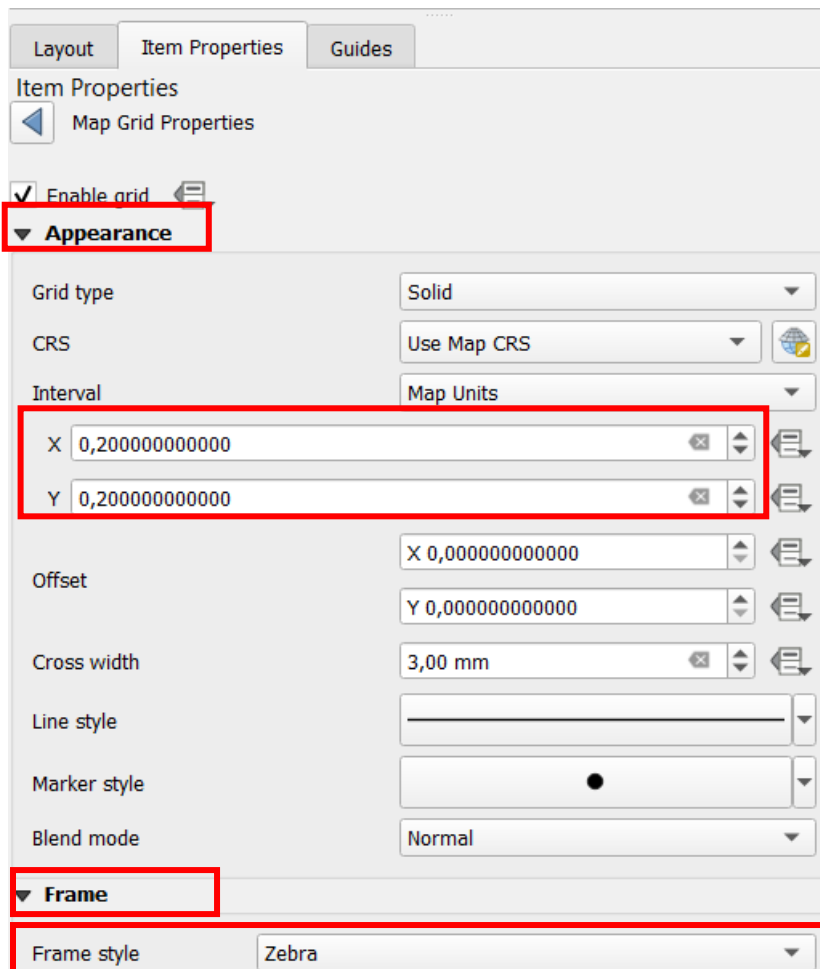


This opens up the many options to modify the grid properties.

In the **Appearance** section.

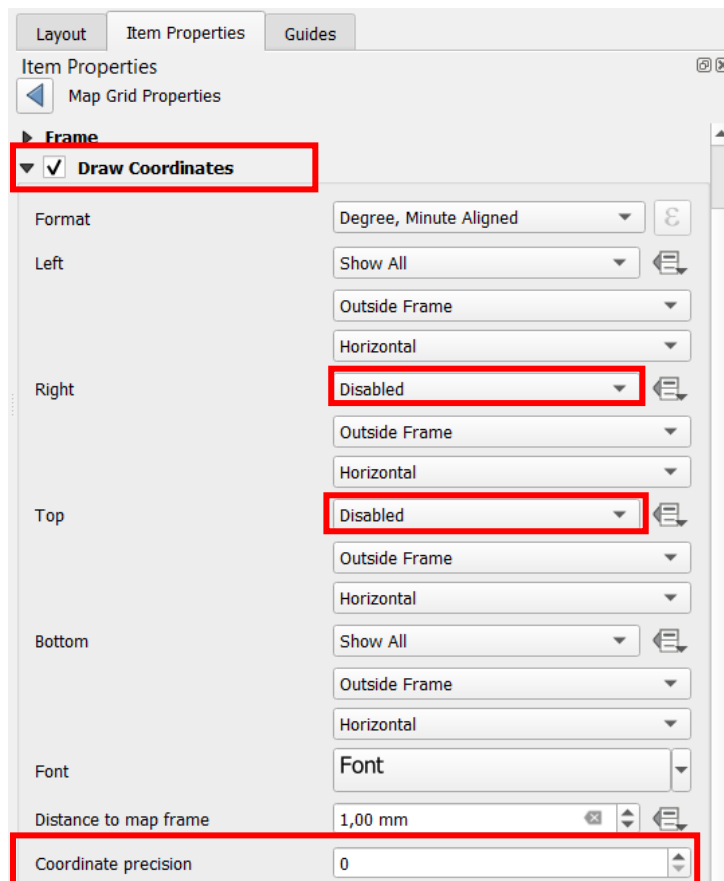
By default, the grid will use the Coordinate Reference System (**CRS**) of the map (in this case EPSG:4326, i.e. using Longitude and Latitude), You will learn about projections and coordinate reference systems in another lesson. We must specify with which **Interval** we would like lines to appear both on the **X** axis, and the **Y** axis (by default in **Map Units**). See what happens when you use different numbers (for example, try the numbers 0.1, 0.2, 0.5). Here, we can use the value of 0.2 for both the **X** and **Y** axis.

In the **Frame** section, under **Frame style**, instead of **No Frame**, select **Zebra**. What changes on the map?

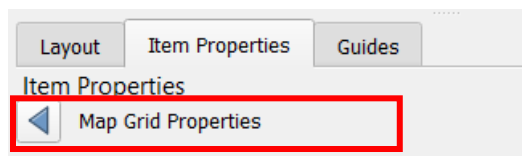


Scroll down to find more **Map Grid Properties**. Check the **Draw Coordinates** box. This will display coordinates on the edges surrounding the map.

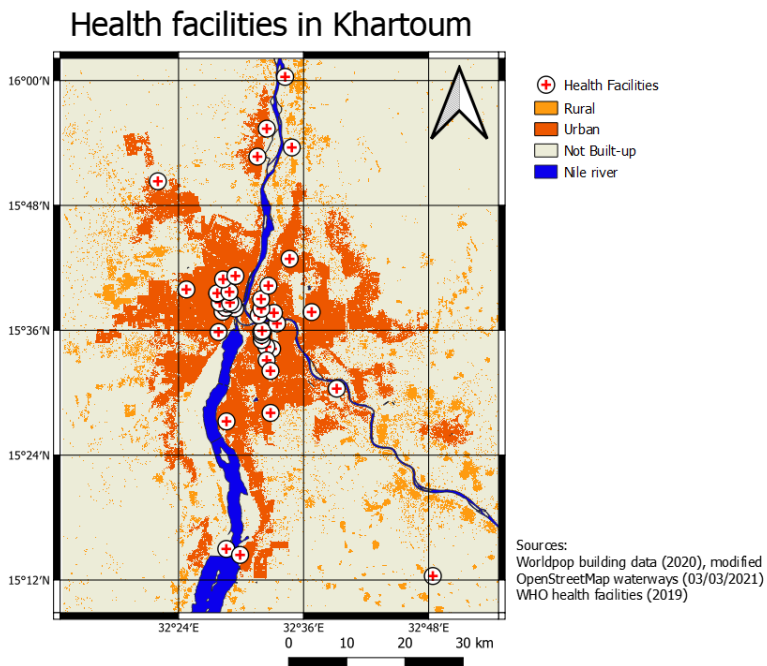
- For the Format, select Degree, Minute Aligned (as we are using the CRS EPSG:4326, we are using Longitude and Latitude. As mentioned earlier, you will learn more about this in another lesson.)
- For the **Right** and **Top** options, change from **Show All**, to **Disabled**. This means the coordinates will only be displayed on the left and bottom sides of the map.
- Change the **Coordinate Precision** to **0** as in this case, it does not provide any additional useful information.



Click on the blue arrow to return from the [Map Grid Properties](#).






Finally, if necessary, readjust the elements on your map.



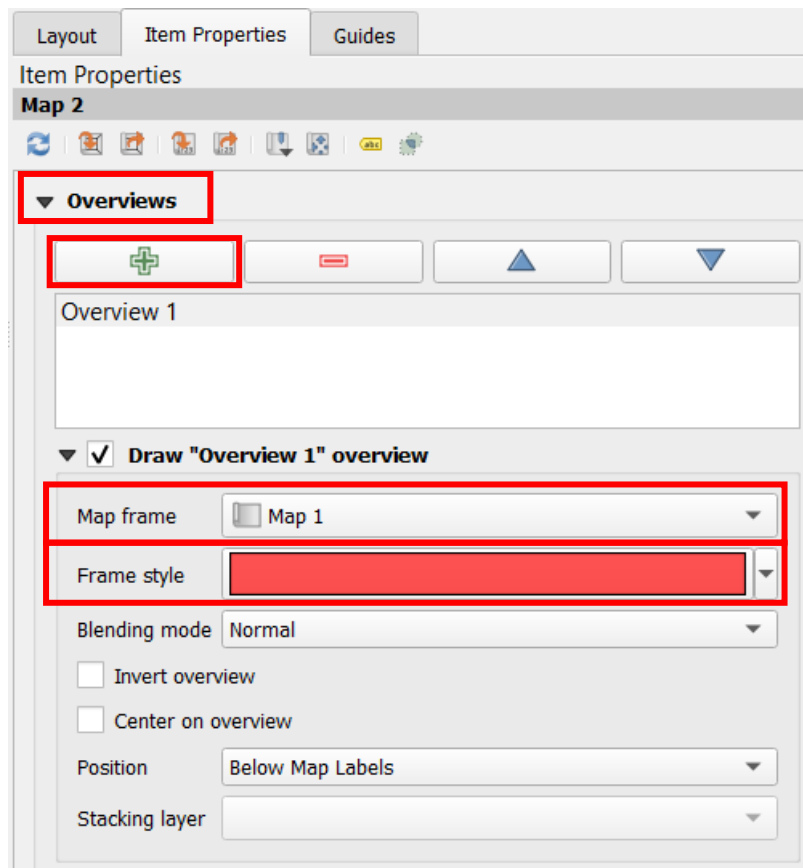
Adding an overview map

Another useful tool is the overview. This can also help a map reader to situate themselves.

First, in the main QGIS window, uncheck all the layers except **Sudan_admin1**, and in the **Layer Properties** of this layer, remove the labels (**Single labels** > **No labels**). Then, back in the print composer, add a new map  (draw a smaller rectangle next to the main map). In the item list, this map is called Map 2. With the map tool  zoom in or out until you can clearly see the whole of Sudan.

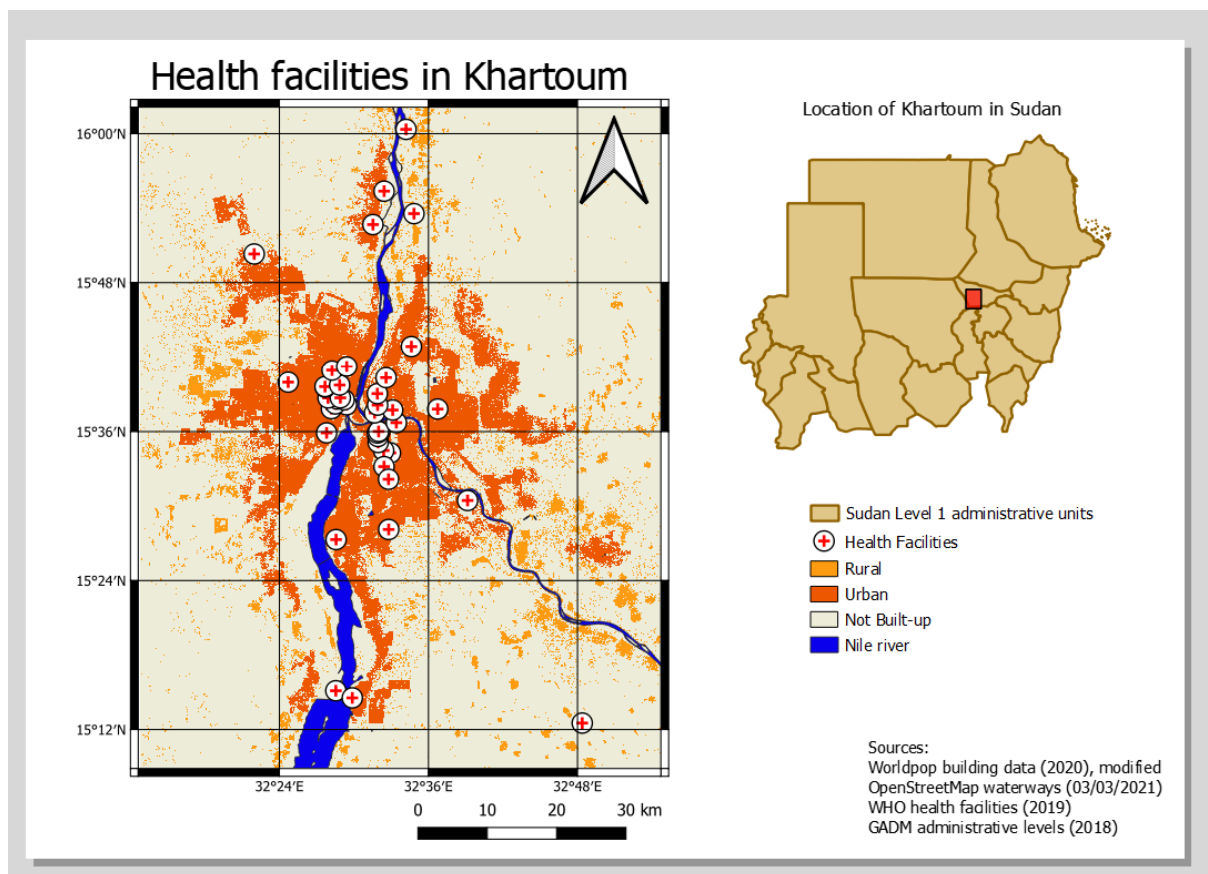
In the **Item Properties**, scroll down to the **Overviews** section and click on the little arrow to open the options ► click on the green cross  to add an overview ► in the **Map Frame** option, click on **Map 1**.

You will see a small pink square appear on the map of Sudan (**Map 2**), that corresponds to the footprint (geographical area) covered by the map of Khartoum (**Map 1**). It is not very obvious here, but you can change the **Frame Style** (like with changing the symbology of a vector layer) to try to make the area stand out further.



As the **Overview** map uses an additional map layer, you can add a second **Legend** to the layout. For this new legend, in the **Map Properties** select **Map 2** (instead of **Map 1**), uncheck **Auto update**, and check **Only show items inside linked map**, and rename to something more appropriate. You can position this above the first legend. The sources list should also be updated to include this additional source. You can also add a smaller title above **Map 2**, e.g. **Location of Khartoum in Sudan**.

If necessary, rearrange the elements on the map, and export the map if you wish.



11. Additional information and tutorials

In this section are multiple links, either providing more information on QGIS, or other existing free tutorials on QGIS. Please use this information should you need, but do not feel obliged to go through it all !! You can use them for help if you have any areas that you particularly struggle with, or for additional practice in your own time.

Links for more information

From the QGIS user manual: https://docs.qgis.org/testing/en/docs/user_manual/index.html

[QGIS graphical user interface \(GUI\)](#)

[Browser panel](#)

[Layer properties for vectors](#)

[Layer properties for rasters](#)

[Overview of the print layout](#)

[Plugins](#)

[Project files](#)

A Gentle introduction to GIS – This gives some introductory theory to GIS

https://docs.qgis.org/testing/en/docs/gentle_gis_introduction/index.html

[Map production](#)

Other tutorials

QGIS training manual: https://docs.qgis.org/testing/en/docs/training_manual/index.html

[Creating a basic map](#)

[Using the print layout](#)

[Plugins](#)

QGIS tutorials and tips: <https://www.qgistutorials.com/en/index.html>

QGIS manual for digital cartography in censuses and surveys. This tutorial covers some aspects that we covered in Lesson 2, but also covers more advanced data manipulation in QGIS, some of which will also be covered in this course. An advantage of this tutorial is that it also exists in Arabic.

<https://www.unfpa.org/resources/qgis-digital-cartography-censuses-and-surveys>