

## GIS TUTORIAL 3: Simple Geospatial Analysis with QGIS

In this tutorial we will be learning some simple geospatial analyses related to elevation and hydrology with QGIS. This will help us to learn more about our sites. We will be using data from the database as well as data that we download from the internet.

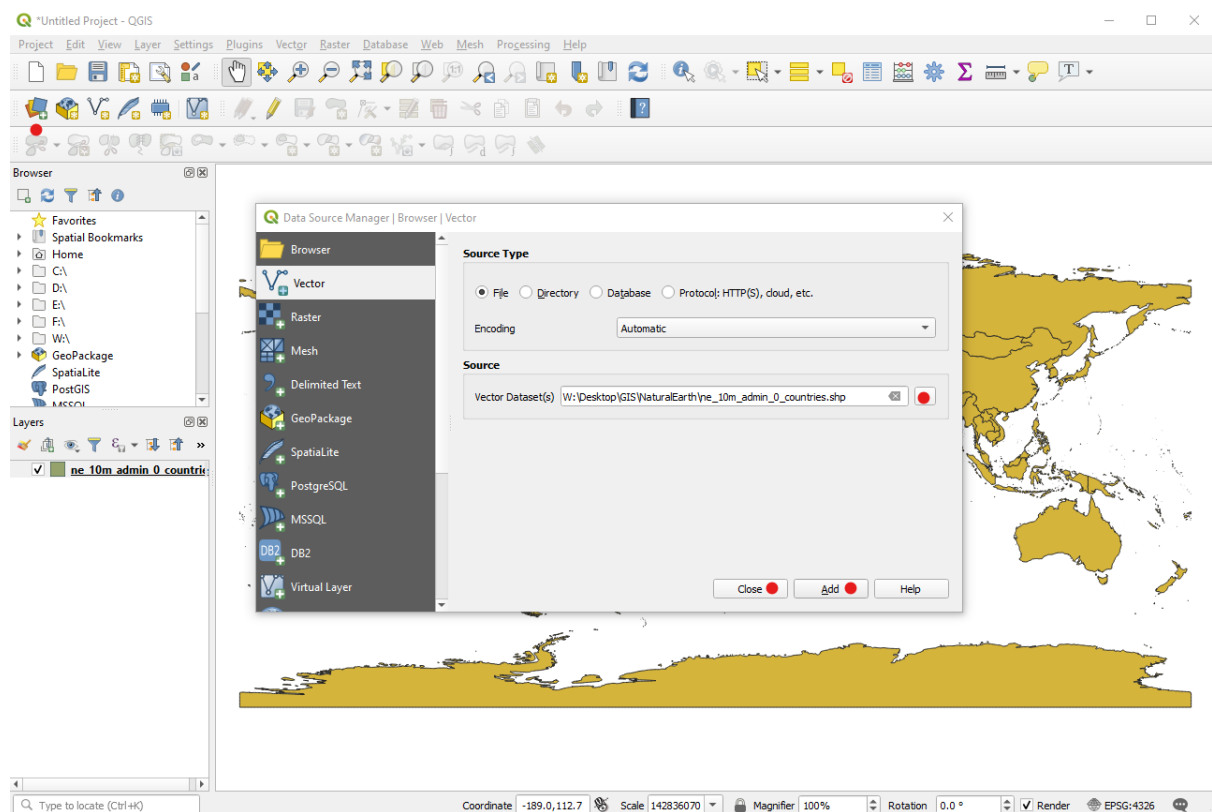
### 1 Sourcing Elevation and Hydrological Data (video tutorial playlist)

We are going to find and download elevation and hydrological data and display it alongside data from the database in QGIS.

#### 1.1 Preparing EAMENA data for analysis in QGIS (video tutorial)

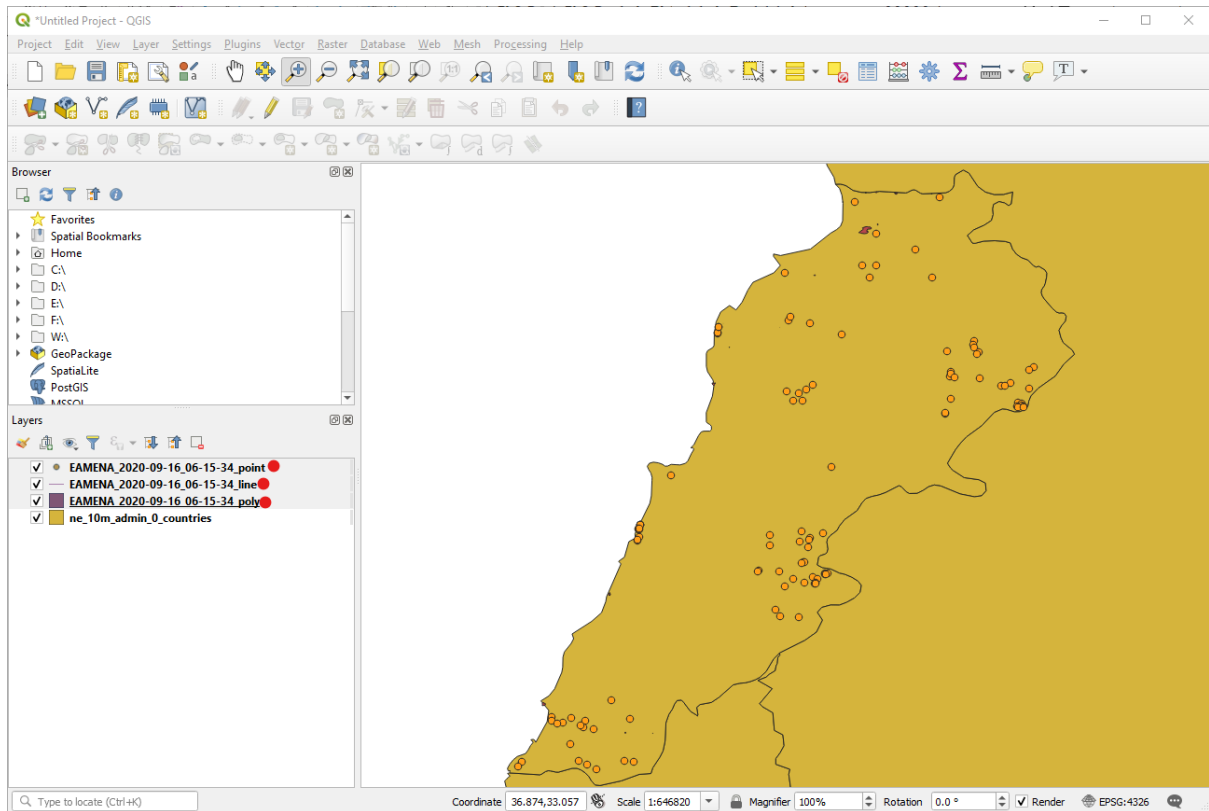
Before we download any other data, we first need to open and prepare some EAMENA data for analysis in QGIS. Before that, we are going to add the NaturalEarth country shapefile that we have already downloaded into QGIS.

- Use the Open Data Source Manager button on the Toolbar to add the NaturalEarth country data to your map.



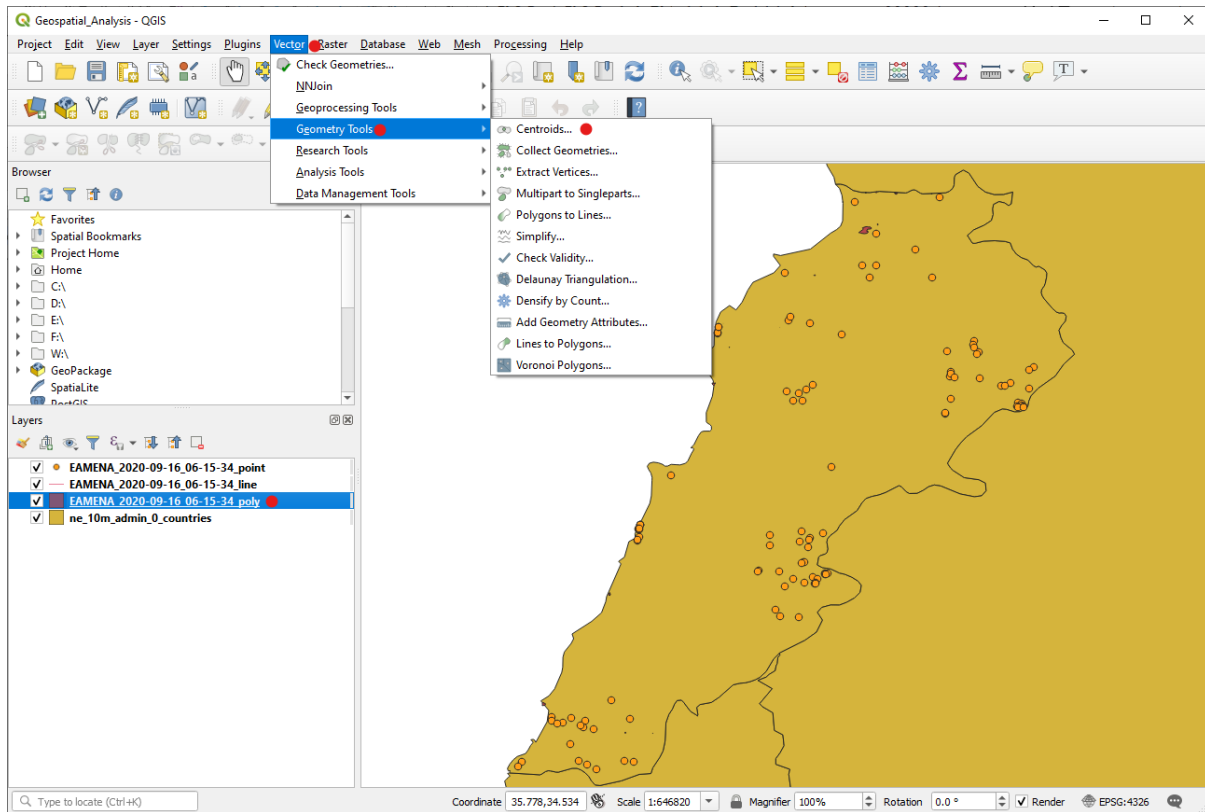
- Export some data as a shapefile from the EAMENA website for your area of interest.
  - Refer to **Tutorial 19: Exporting from the Database** for detailed instructions how to do this.
  - For this tutorial we will use an export of all the Roman period sites in Lebanon.

- Add this data to QGIS using the Data Source Manager

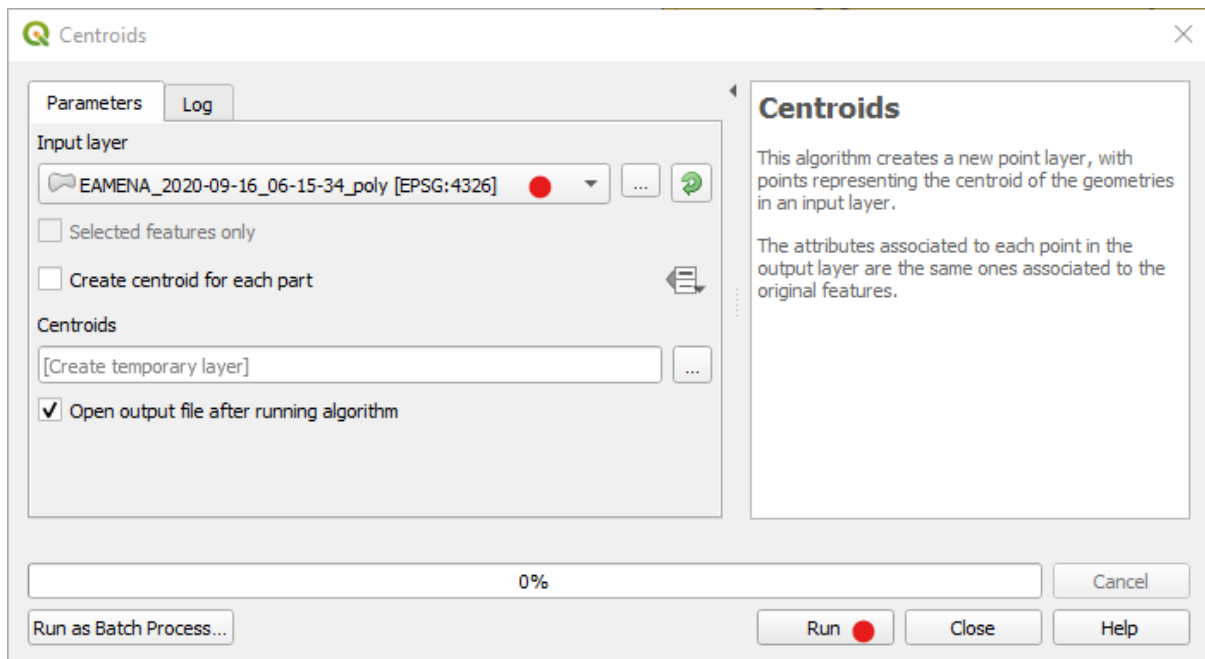


You are likely to have a combination of polygon, line and point data when exporting from the EAMENA database. We need to convert all our data into point data so that we can easily work with it in a single file.

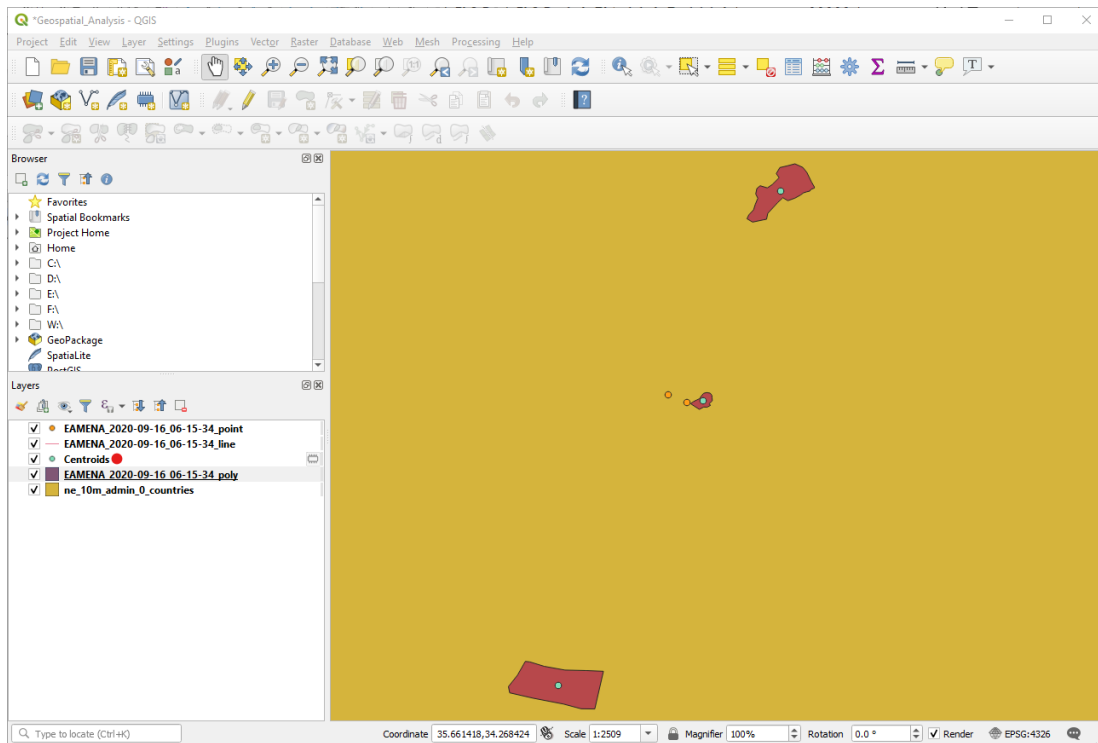
- Click on the polygon file in the Layers Panel
- On the Menu go to “Vector” > “Geometry Tools” > “Centroids...”



- Make sure that the polygon layer is selected and click “Run”



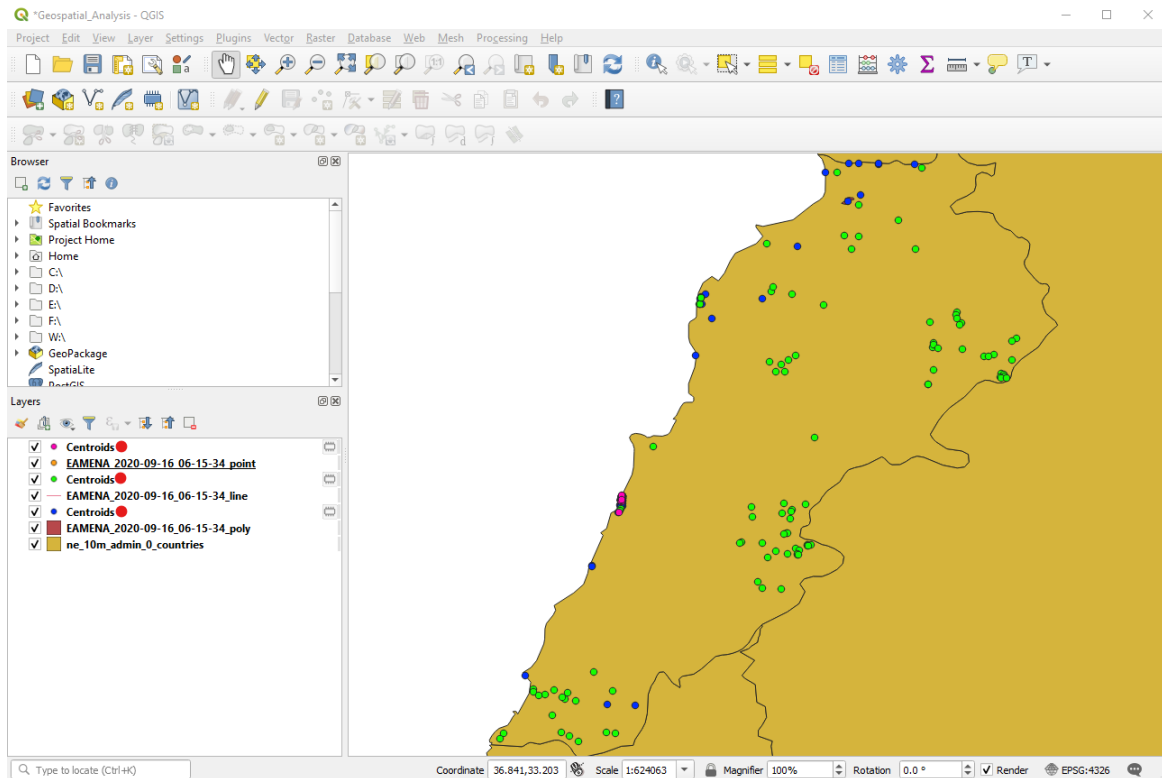
A new “Centroids” point layer will be created above the polygon layer, appearing as a point in the centre of each polygon.



- Repeat this process for your line and point shapefile data

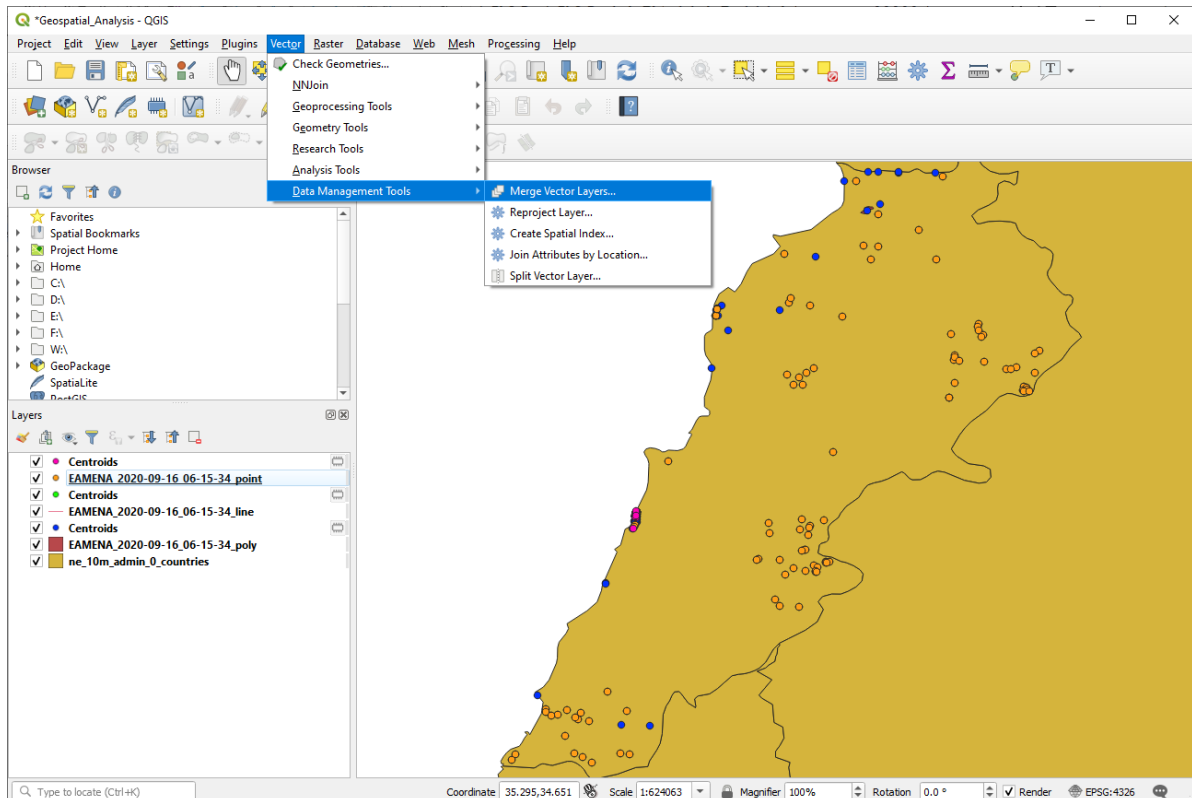
Although it may seem strange, we do need to do this for the points layer too, this is in case one site has more than one point in the shapefile.

You will end up with three “Centroids” point layers above each of your original EAMENA shapefiles.

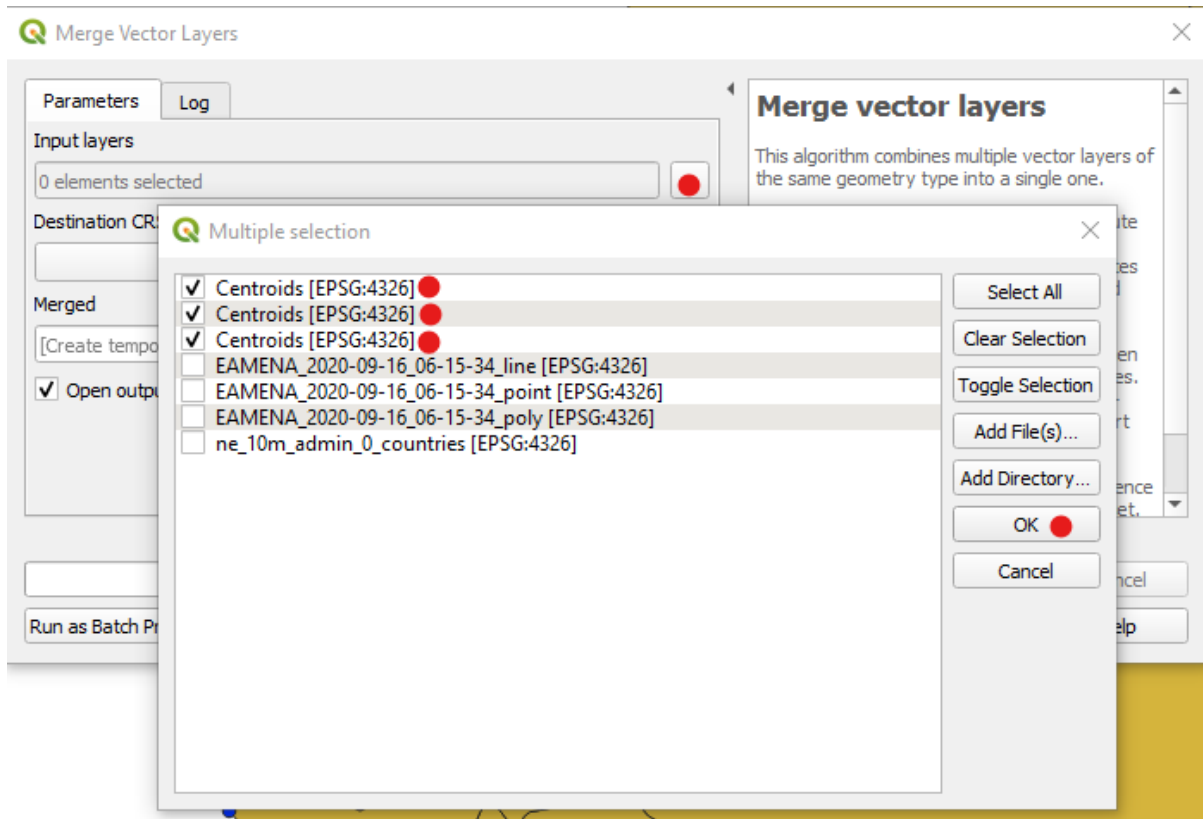


These now need to be combined into a single point shapefile.

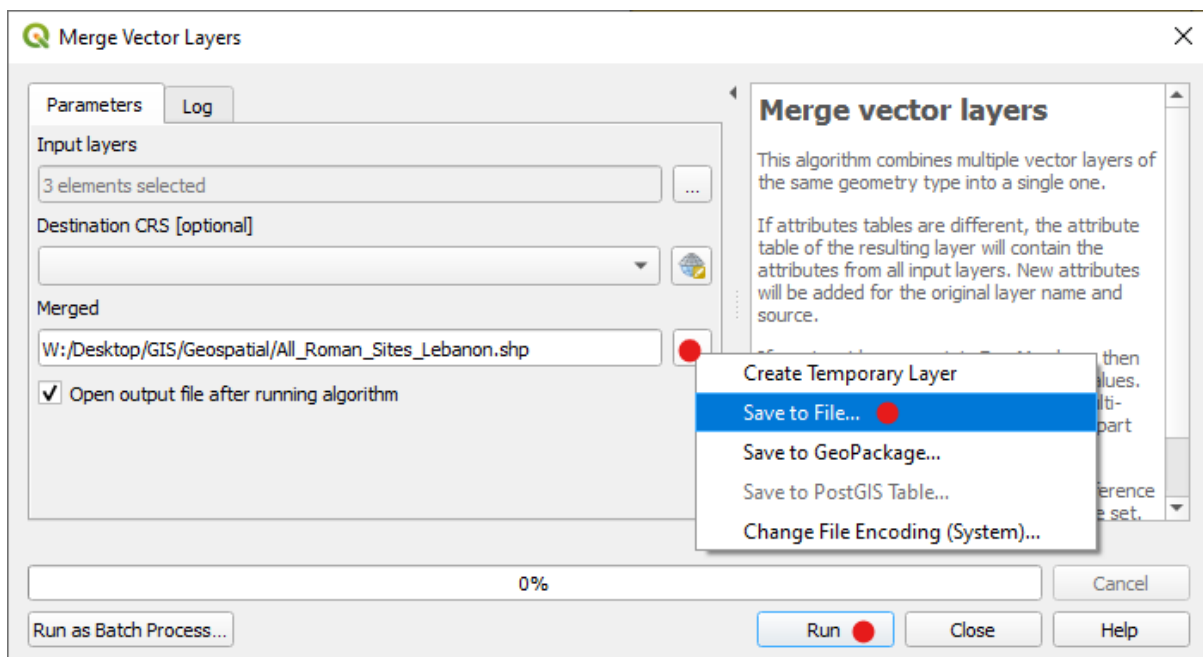
- On the Menu click “Vector” > “Data Management Tools” > “Merge Vector Layers...”



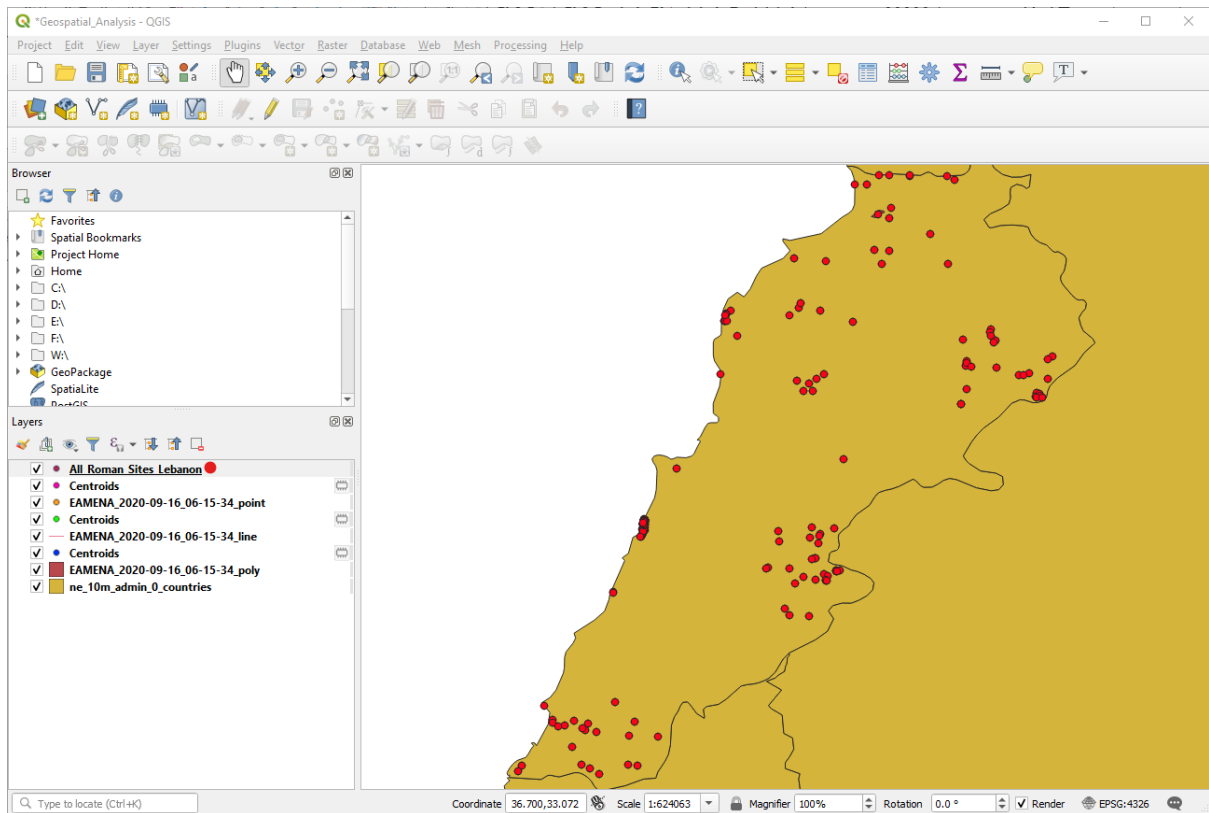
- Click the “Browse” [...] button next to “Input layers” and tick the three “Centroids” layers and click “OK”.



- Click the “Browse” [...] button next to “Merged” and “Save to File...” and give the merged file a name in your suitable folder within your GIS folder.
- Click “Run” and then “Close” when it has finished.

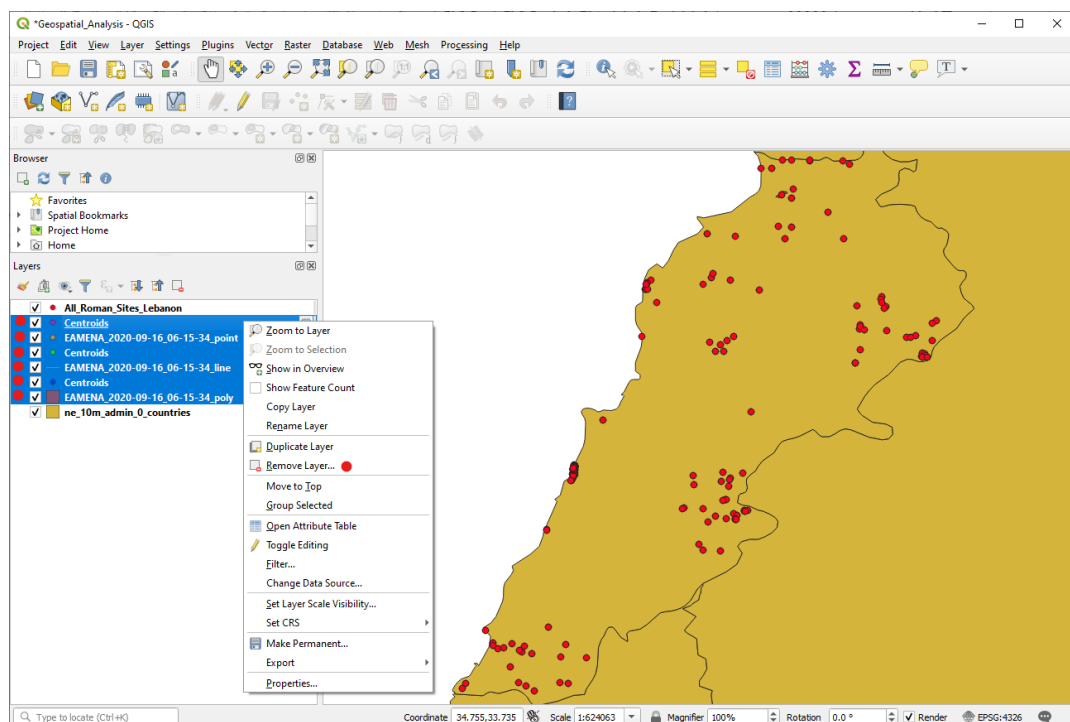


You will now see your new merged layer in the Layers Panel and, when you move it to the top, covering every site in the Map View Window.

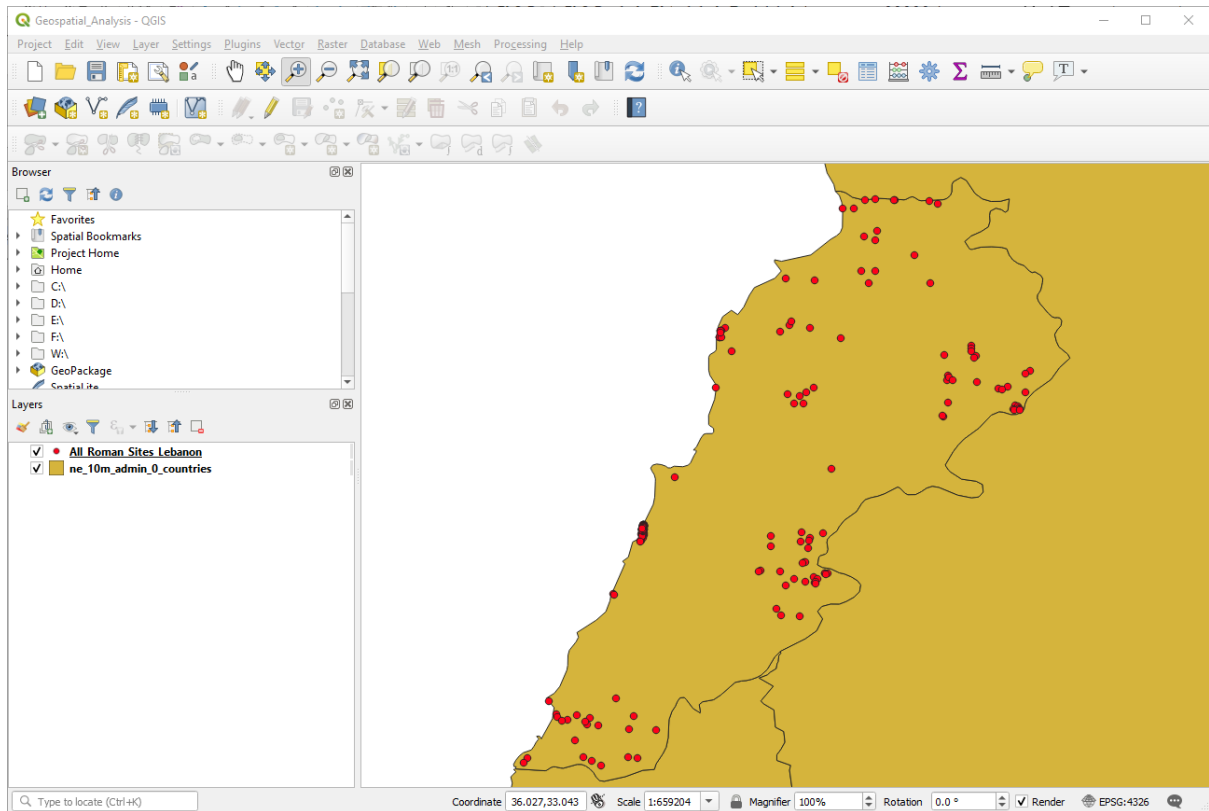


We can now remove all of the old layers that we do not need.

- Press and hold the [Ctrl] key on your keyboard (or [cmd] if you are using a Mac) and click all the old shapefile and centroid layers.
- Right-click one of these layers while holding [Ctrl] and click “Remove layer”.



You will be left with just your merged point layer and the country data.

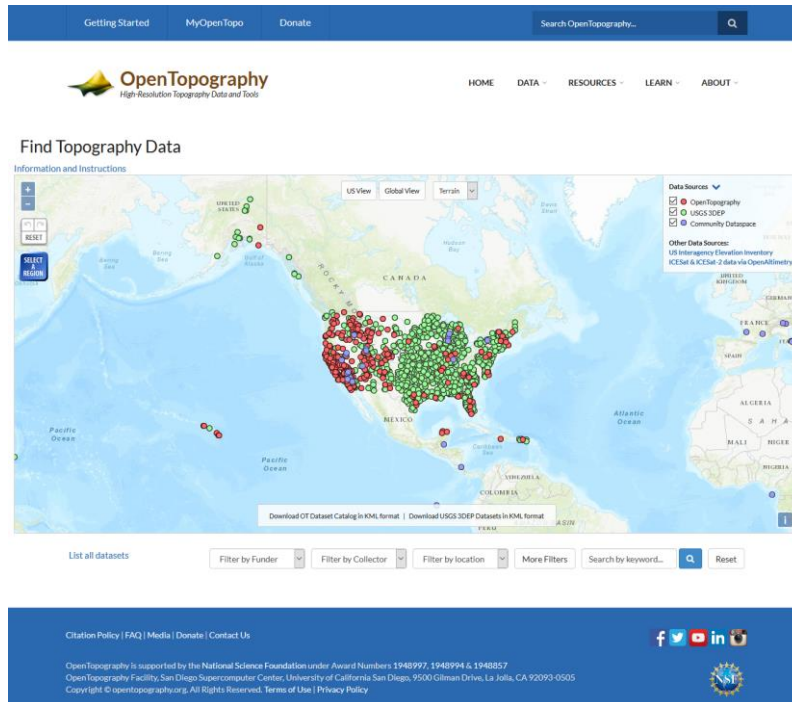




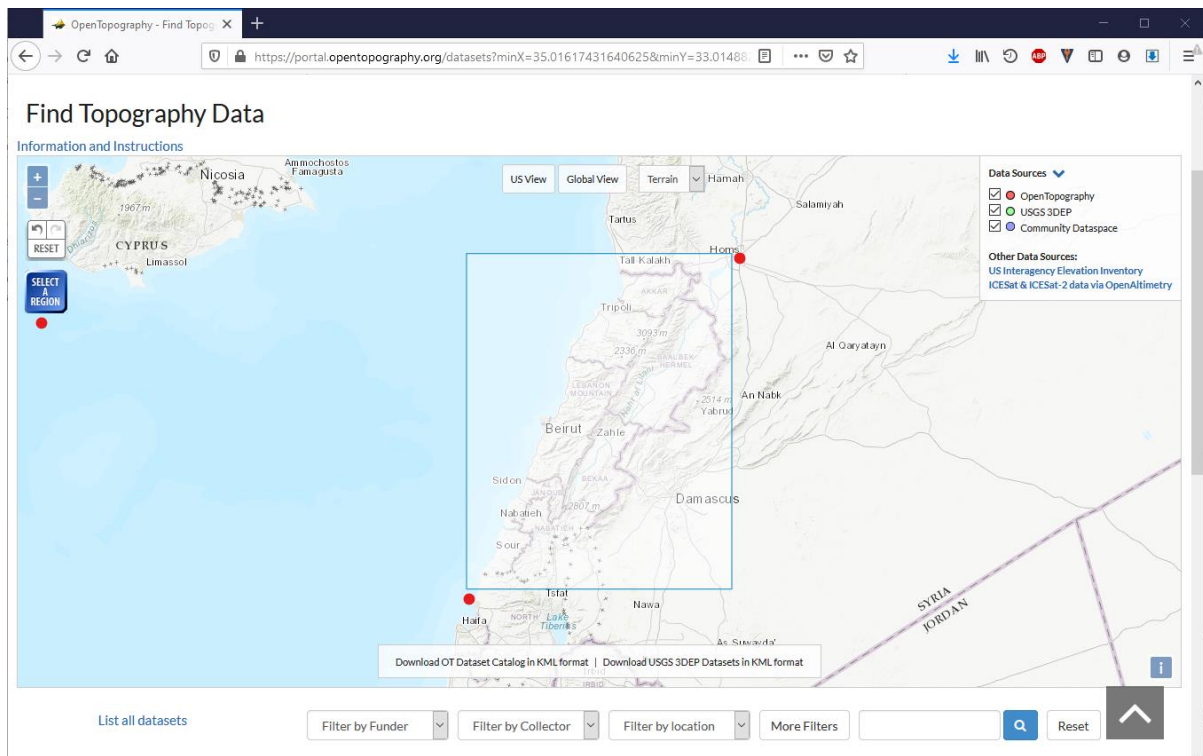
## 1.2 Downloading and adding elevation data (video tutorial)

Now that we have our EAMENA site data ready to analyse, we are ready to download and add some elevation data to our map.

- In your internet browser go to <https://portal.opentopography.org/datasets>



- On the map zoom into your area of interest
- Click “SELECT A REGION” and click and drag on the map to create an area of interest



- Scroll down on the page and click “Global Data”, and then “SRTM GL1”

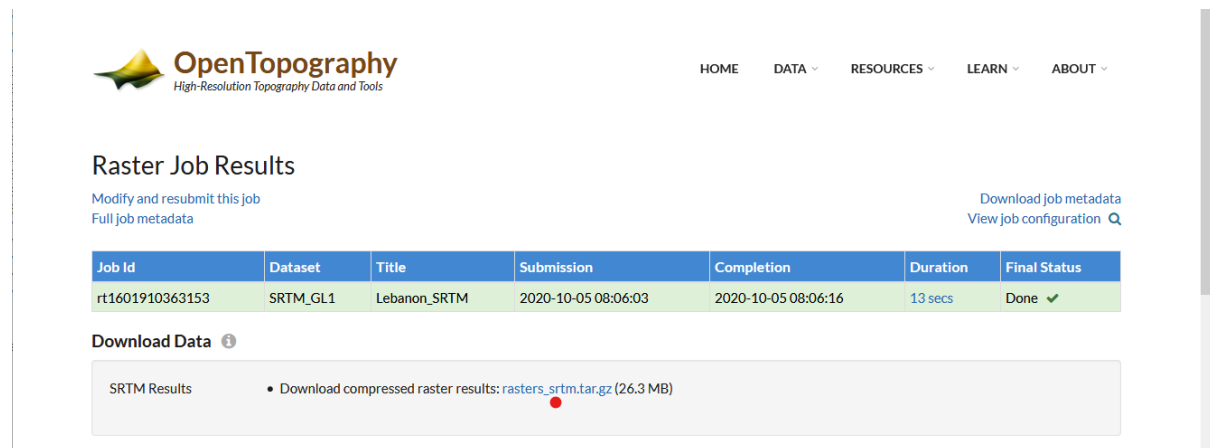
The screenshot shows the OpenTopography website interface. At the top, there's a navigation bar with links: HOME, DATA, RESOURCES, LEARN, and ABOUT. Below the navigation bar, there's a search bar and filters. The main content area shows search results for datasets. A green box indicates "Total 3 datasets found for all data sources." Below this, there are filters for "OT High Resolution Topography: [0]", "USGS 3DEP: [0]", "OT Community Contributed: [1]", and "Global Data: [2]". A list of datasets is shown, including "1 ALOS World 3D - 30m" and "2 Shuttle Radar Topography Mission (SRTM) Global". To the right of the dataset list, there are buttons for "AW3D30 Ellipsoidal", "AW3D30", "SRTM GL3", "SRTM GL1 Ellipsoidal", and "SRTM GL1".

- Scroll down and under “3. Visualisation” untick “Generate hillshade images...”
- Scroll down and give the task a name – e.g. “Lebanon\_SRTM”
- Type your email address and click “Submit”

The screenshot shows the OpenTopography website interface for job submission. The navigation bar is at the top. The main content area has sections for "3. Visualization", "4. Hydrologic Terrain Analysis Products (tauDEM)", and "5. Global Solar Irradiation". Under "3. Visualization", there are checkboxes for "Generate hillshade images from DEMs", "Generate additional color-relief and colored hillshades", and "Generate additional Google Earth KMZ files". Below these sections, there's a "Job Description" section. It includes a "Job title" field with the value "Lebanon\_SRTM", a "Job description" field, and an "Enter your e-mail address" field with the value "william.deadman@durham.ac.uk". At the bottom, there's a "SUBMIT" button.

You will see a screen informing you that your data is being processed.

- When the task completes click on the “rasters\_srtm.tar.gz” file to download it.



**OpenTopography**  
High-Resolution Topography Data and Tools

HOME DATA RESOURCES LEARN ABOUT

### Raster Job Results

Modify and resubmit this job  
Full job metadata

Download job metadata  
View job configuration

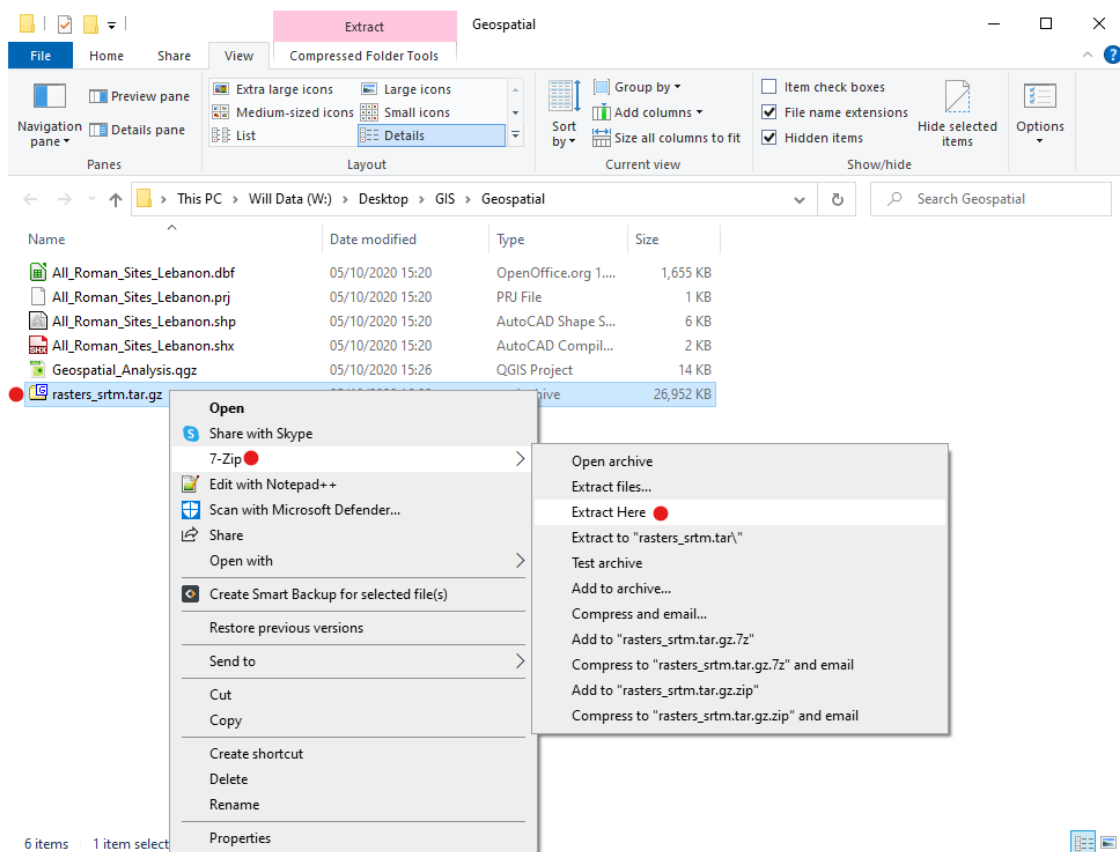
Job Id	Dataset	Title	Submission	Completion	Duration	Final Status
rt1601910363153	SRTM_GL1	Lebanon_SRTM	2020-10-05 08:06:03	2020-10-05 08:06:16	13 secs	Done ✓

**Download Data**

SRTM Results

- Download compressed raster results: [rasters\\_srtm.tar.gz](#) (26.3 MB)

- When the download completes move this file into a suitable folder within your GIS folder
- Right-click the file and select “7-Zip” > “Extract Here”, creating a new “rasters\_srtm.tar” file.



File Home Share View Compressed Folder Tools

Navigation pane Details pane

Layout

Current view

Show/hide

Options

Geospatial

Search Geospatial

Name	Date modified	Type	Size
All_Roman_Sites_Lebanon.dbf	05/10/2020 15:20	OpenOffice.org 1...	1,655 KB
All_Roman_Sites_Lebanon.prj	05/10/2020 15:20	PRJ File	1 KB
All_Roman_Sites_Lebanon.shp	05/10/2020 15:20	AutoCAD Shape S...	6 KB
All_Roman_Sites_Lebanon.shx	05/10/2020 15:20	AutoCAD Compil...	2 KB
Geospatial_Analysis.qgz	05/10/2020 15:26	QGIS Project	14 KB
rasters_srtm.tar.gz		Archive	26,952 KB

Open

Share with Skype

7-Zip

Edit with Notepad++

Scan with Microsoft Defender...

Share

Open with

Create Smart Backup for selected file(s)

Restore previous versions

Send to

Cut

Copy

Create shortcut

Delete

Rename

Properties

Open archive

Extract files...

Extract Here

Extract to "rasters\_srtm.tar\"

Test archive

Add to archive...

Compress and email...

Add to "rasters\_srtm.tar.gz.7z"

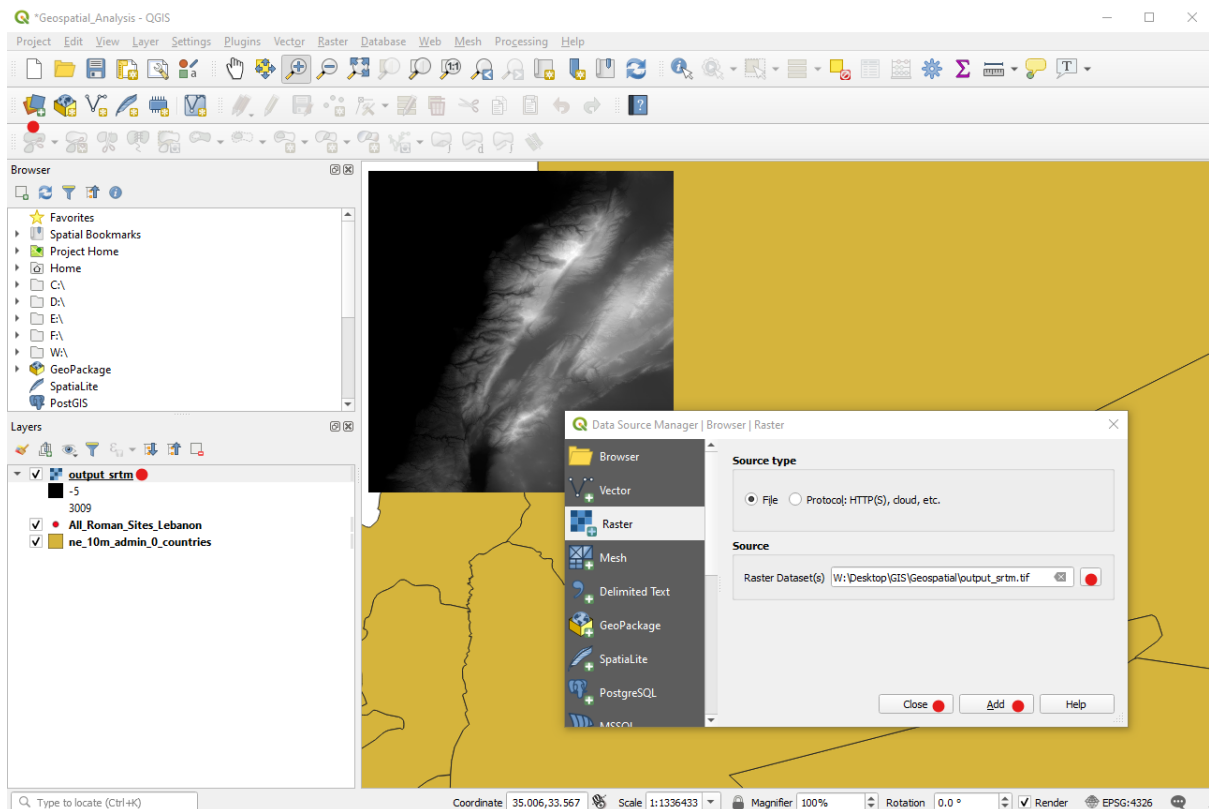
Compress to "rasters\_srtm.tar.gz.7z" and email

Add to "rasters\_srtm.tar.gz.zip"

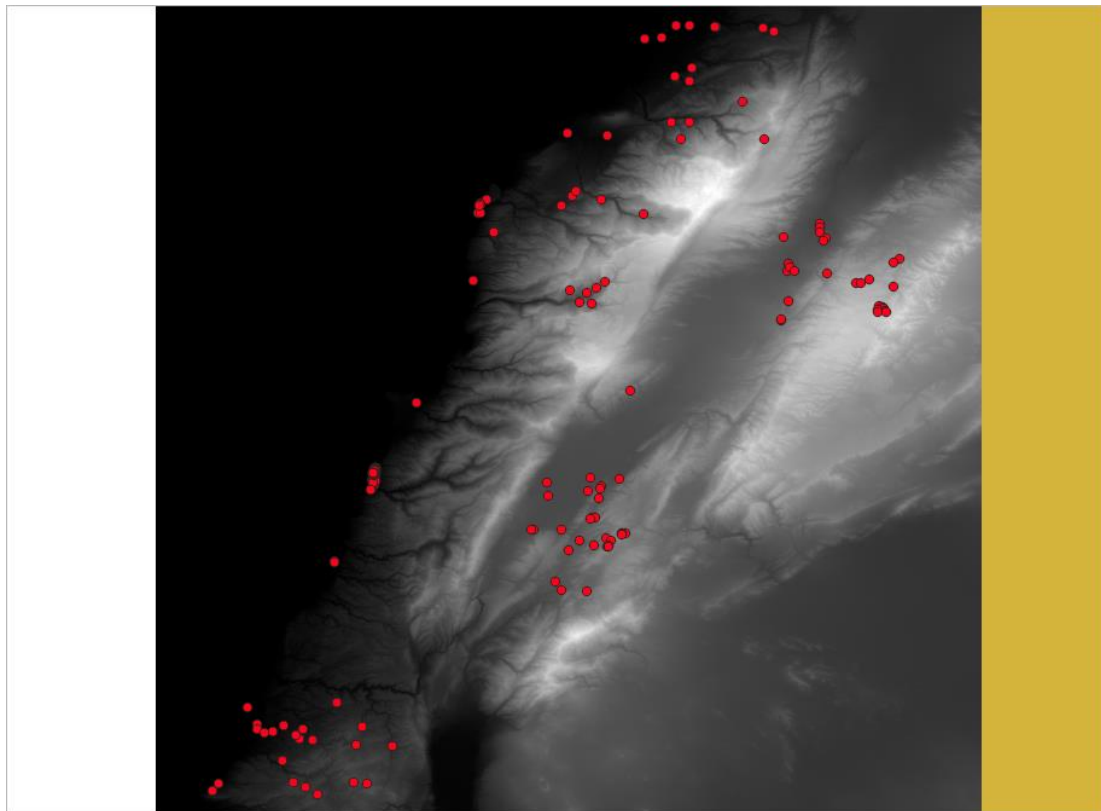
Compress to "rasters\_srtm.tar.gz.zip" and email

- Use 7-Zip to extract this file too (it is double-zipped), creating a new “output\_srtm” file

- In QGIS use the Open Date Source Manager to add this to your map



You now have elevation data for your area of interest.

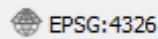


### 1.3 Visualising elevation data (video tutorial)

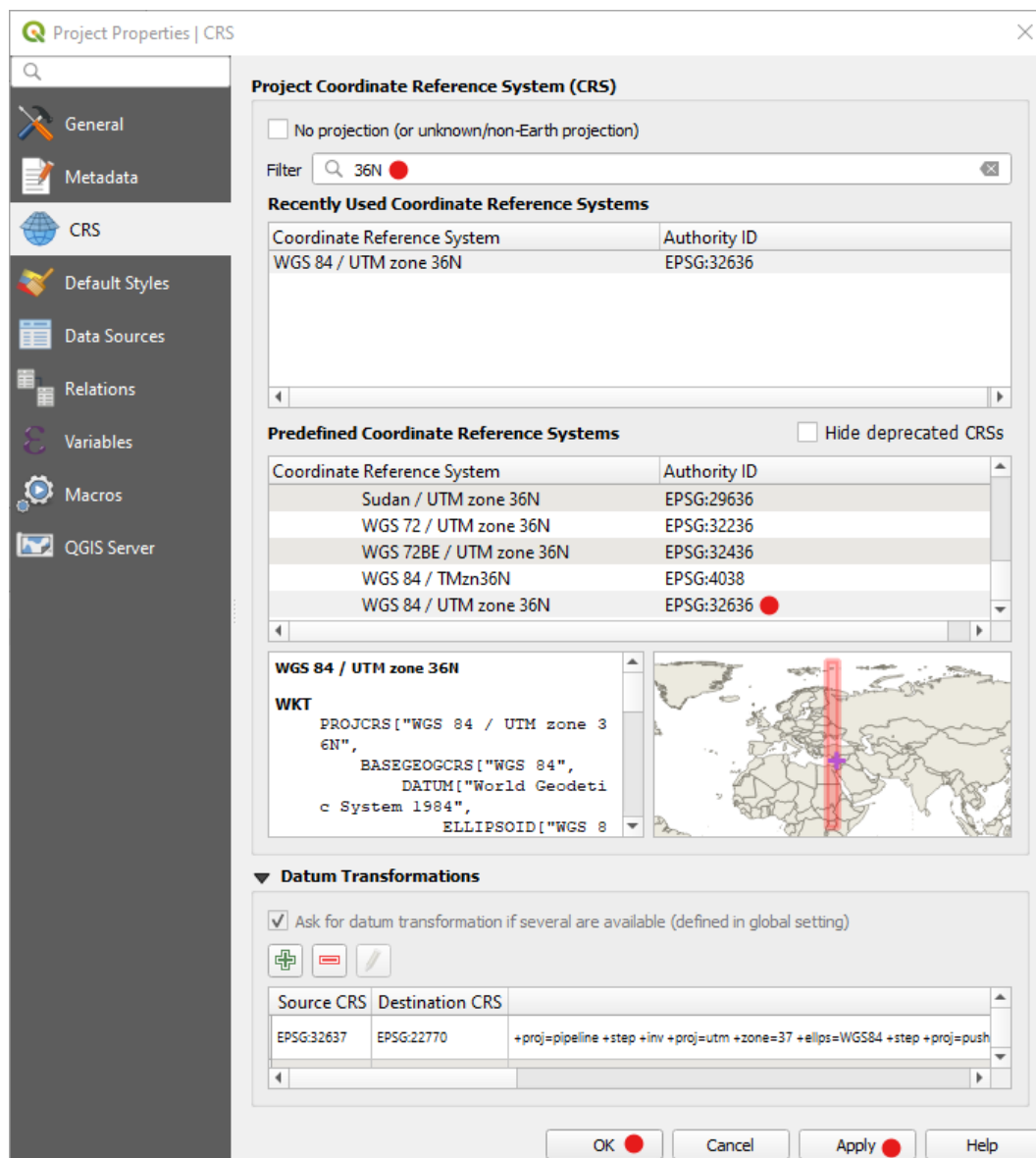
Now that we have added the elevation data to our map, we can now make it easier to read and more attractive.

First, we need to change the coordinate reference system (CRS) of the elevation data and our site data.

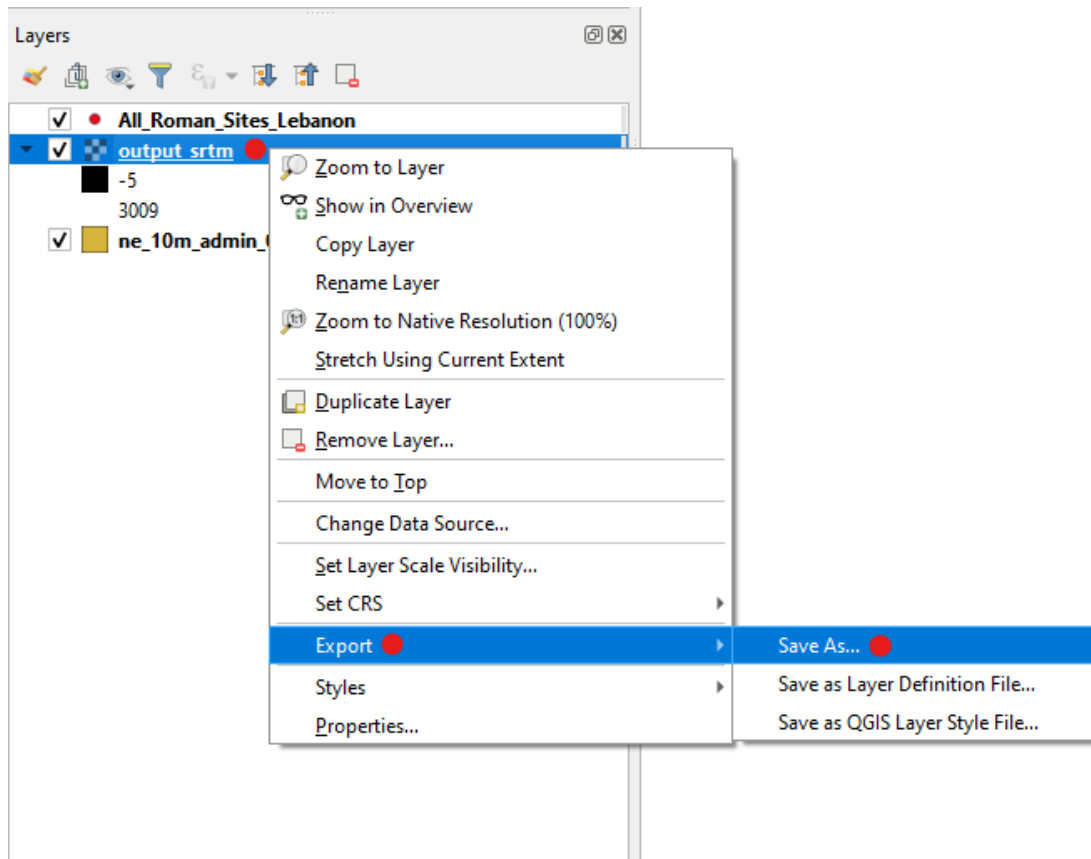
- Press the CRS button at the bottom right of the screen



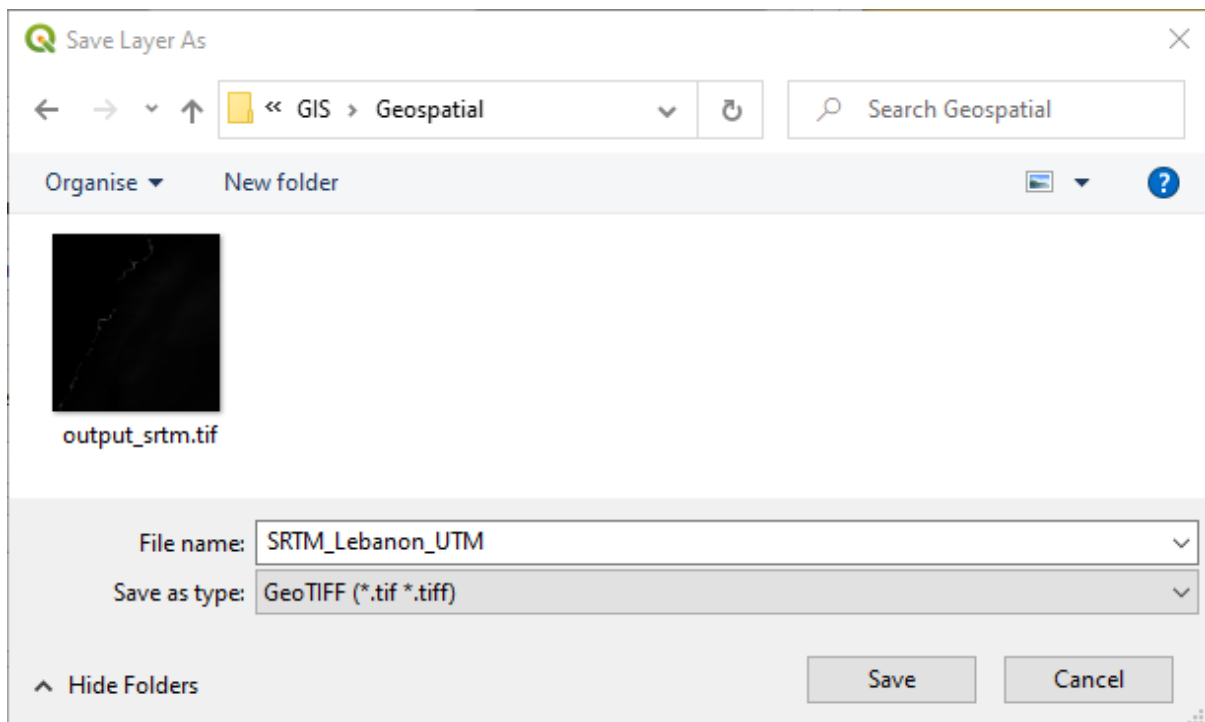
- Type in the UTM zone for your area of interest (e.g. 36N).
  - If you do not know it, you can find it here <https://mangomap.com/robertyoung/maps/69585/what-utm-zone-am-i-in-#>
- Scroll down until you see the option with “WGS 84 / UTM zone [your zone e.g. 36N]”, click on this and Apply and OK.



- In the Layers Panel, right-click the SRTM raster and select “Export” > “Save As”.



- Click the Browse button [...] next to “File name” and save your new file in your “Geospatial” folder with a new name e.g. “SRTM\_Lebanon\_UTM”.



- Change “CRS” to “Project CRS” and make sure that this matches the UTM Zone you have just chosen for the entire map.

**Save Raster Layer as...**

Output mode: ☒ Raw data ☐ Rendered image

Format: **GeoTIFF** ☐ Create VRT

File name: **W:\Desktop\GIS\Geospatial\SRTM\_Lebanon\_UTM.tif**

Layer name:

CRS: **Project CRS: EPSG:32636 - WGS 84 / UTM zone 36N**

**Extent (current: layer)**

North: **3850171.1486**  
 West: **684557.0353** East: **841796.9732**  
 South: **3654739.9268**

**Resolution (current: layer)**

☒ Horizontal **24.8466** ☐ Columns **6328**  
☐ Vertical **31.5254** ☐ Rows **6199**

☒ **Create Options**

Profile: **Default**

Name	Value

☒ Add saved file to map

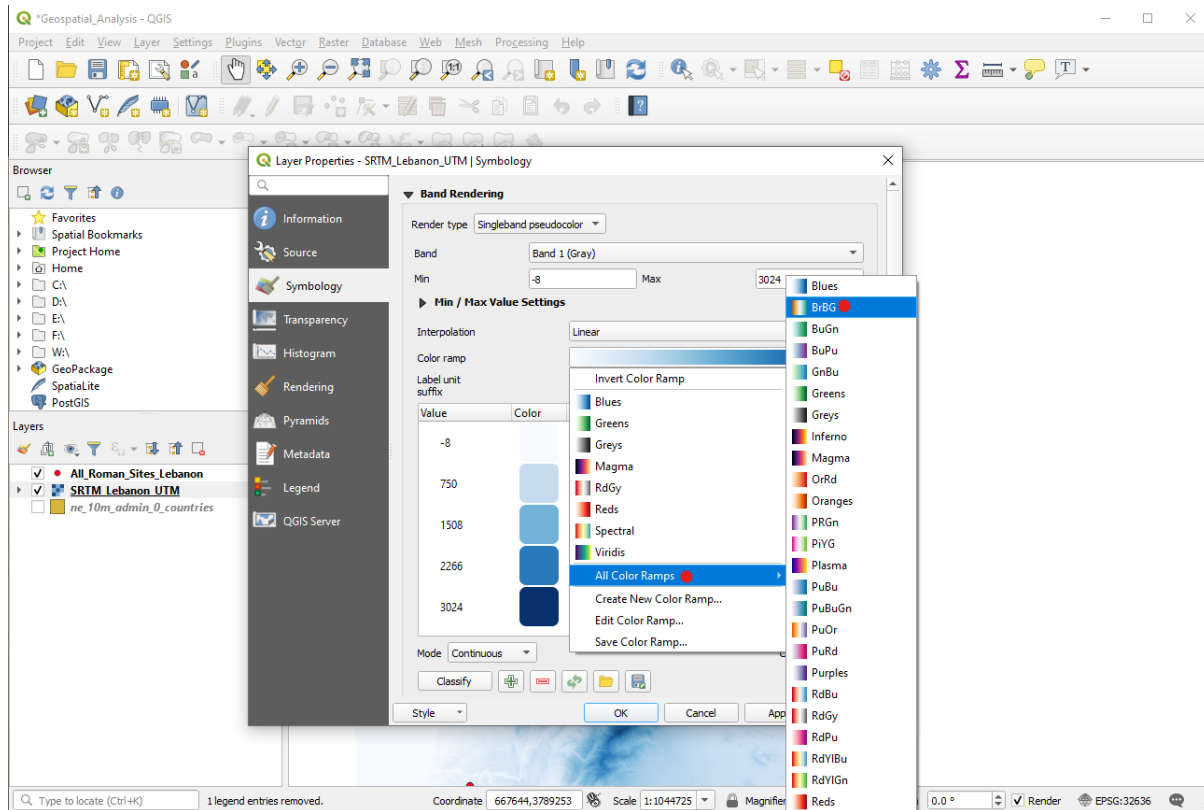
You should now have your new SRTM raster in the Layers Panel.

- Remove the old one by right-clicking “output\_srtm” and selecting “Remove layer”

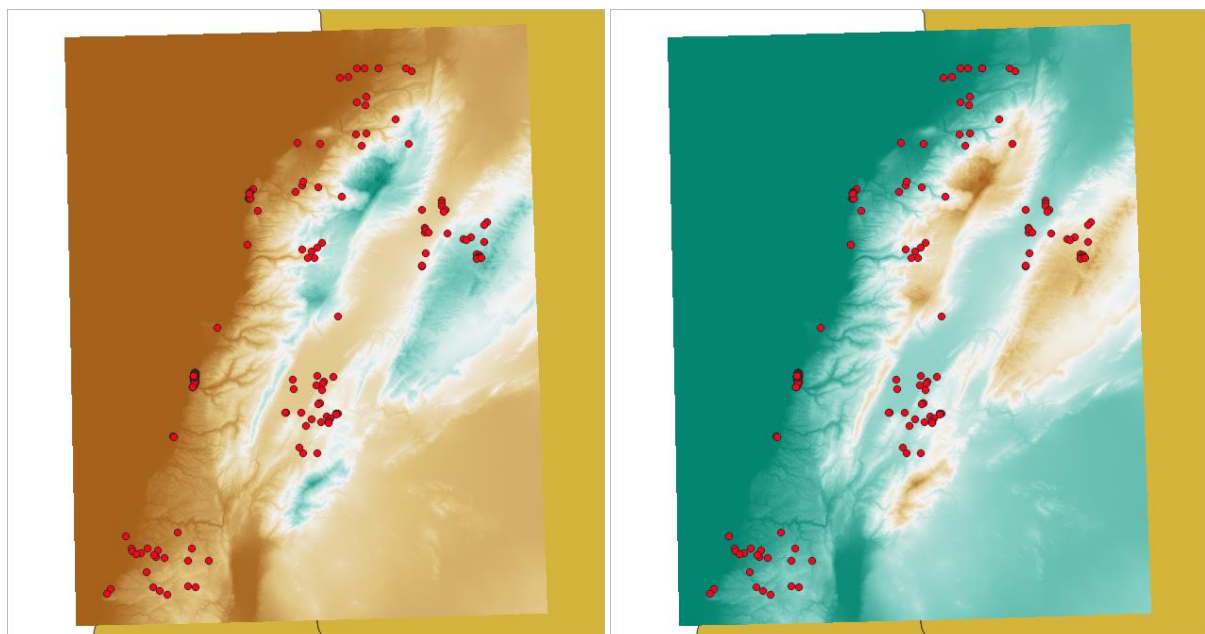


Now we are going to change the symbology of our new SRTM raster.

- Right-click your new raster in the Layers Panel and select “Properties”.
- Click on the symbology tab.
- Change “Render type” from “Singleband gray” to “Singleband pseudocolour”.
- Click the black arrow next to “Color ramp”.
- Click “All Color Ramps” to see more options and click to select the one you want.

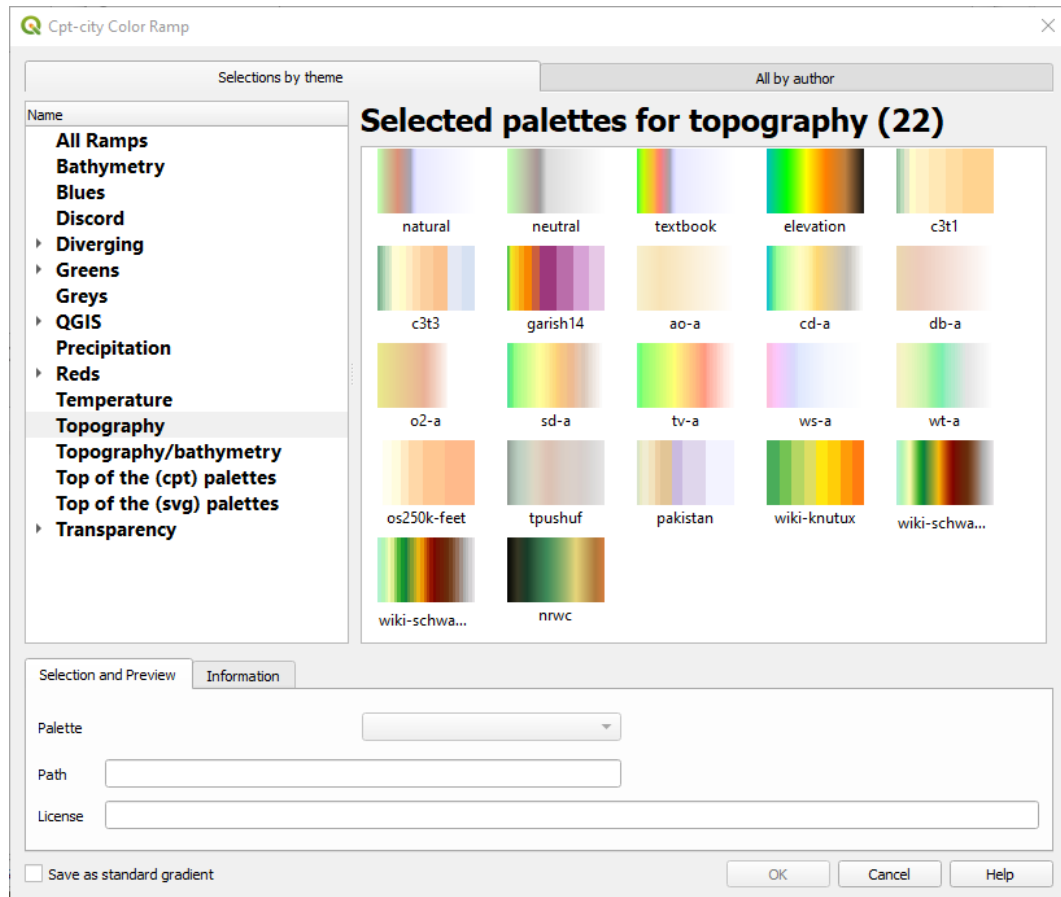


- You can reverse the colours by clicking the arrow again and selecting “Invert ramp”



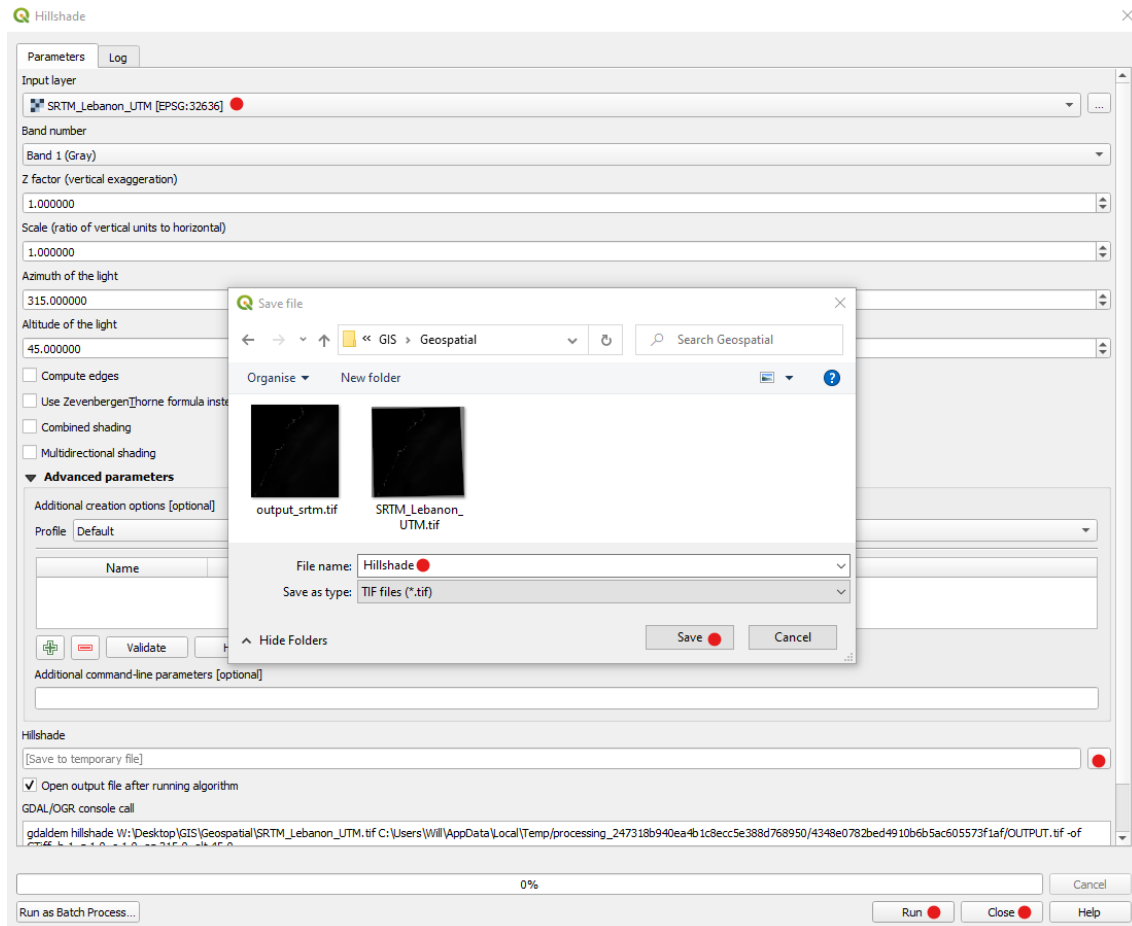


- You can also find more options (including ones specifically designed for topography) by clicking “Create new ramp” > “Catalog: cpt-city”.

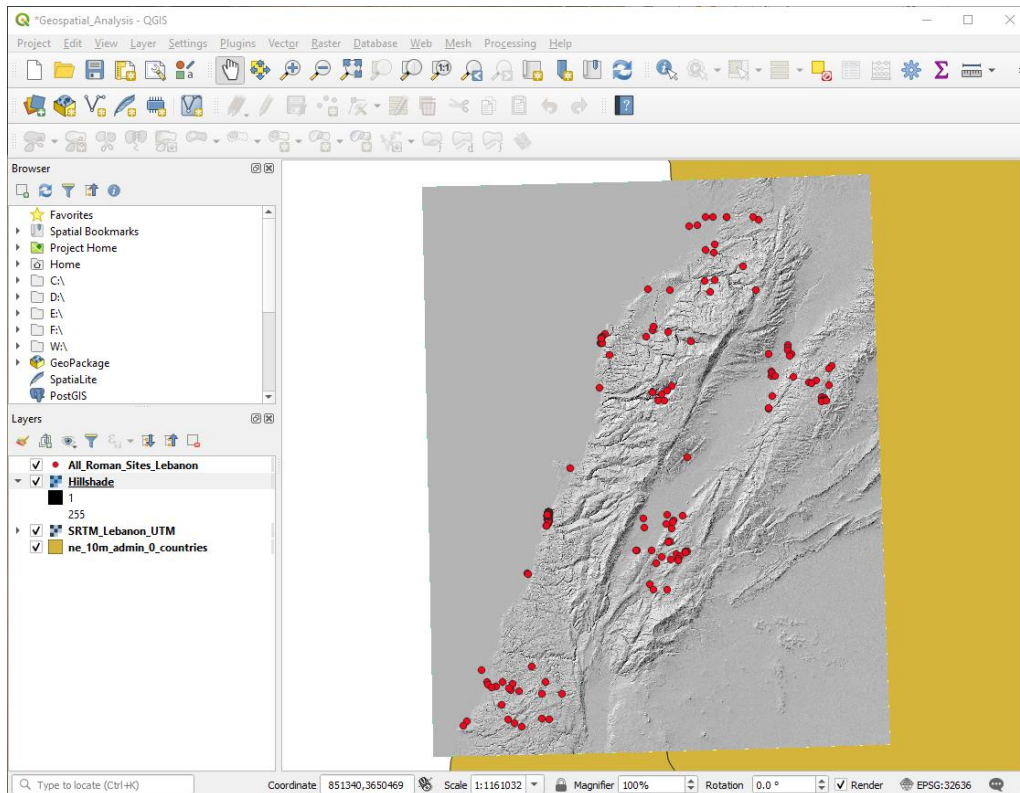


Once we are happy with the colours, we are going to create a second layer that provides some added detail.

- On the Menu click Raster > Analysis > Hillshade.
- In the new window make sure that your UTM raster is selected and then scroll down to “Hillshade”.
- Click the Browse button [...] and select “Save to File...”.
- Navigate to your Geospatial folder and save your new raster as “Hillshade”.
- Click Run and then Close when it has finished.

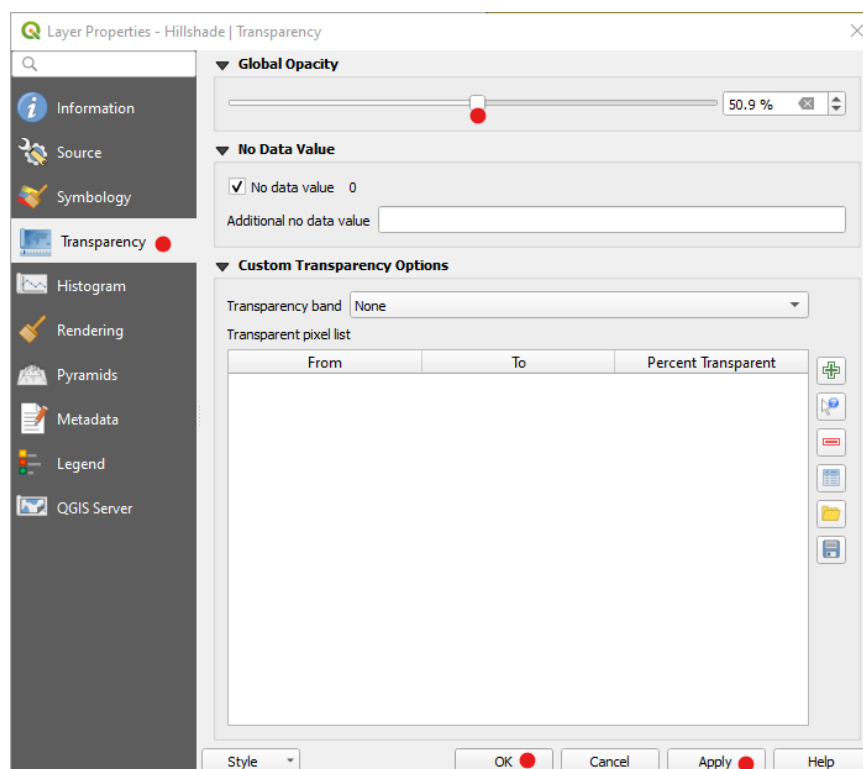


Your new “Hillshade” raster will appear in the Layers Panel and in the Map View

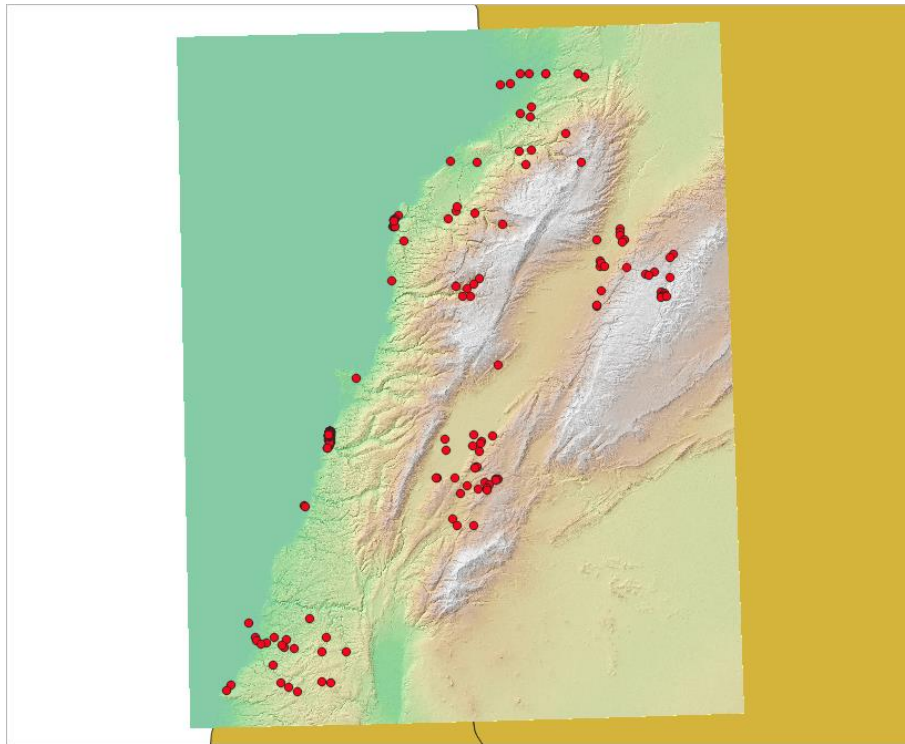


We are going to combine this with the colourful SRTM raster by making it partially transparent.

- Right-click your hillshade raster in the Layers Panel and select “Properties”.
- Click on the “Transparency” tab.
- Use the slider to change the Global Opacity to approximately 50%, click Apply and OK.



As long as your Hillshade raster is above your SRTM raster in the Layers Panel, you should now be able to see added relief detail, creating a much more attractive map.



#### 1.4 Adding hydrological data (video tutorial)

As well as elevation data, we can also obtain hydrological data from the internet to further improve our map.

- On your internet browser visit the HydroSHEDS website  
<https://hydrosheds.org/page/hydrorivers>

This website contains river, lake and basin data that is available to download for free. You can download data by region or for the entire globe.

- For most of the Middle East you need the Europe dataset.
- For North Africa you need the Africa dataset.
- Scroll down to “Shapefiles” and click the “Download” button next to Europe or Africa

##### Shapefiles •

Global	520 MB	<a href="#">Download</a>
Africa	103 MB	<a href="#">Download</a> •
Arctic	21 MB	<a href="#">Download</a>
Asia	86 MB	<a href="#">Download</a>
Australia	47 MB	<a href="#">Download</a>
Europe	65 MB	<a href="#">Download</a> •
Greenland	9 MB	<a href="#">Download</a>
North America	63 MB	<a href="#">Download</a>
South America	91 MB	<a href="#">Download</a>
Siberia	45 MB	<a href="#">Download</a>



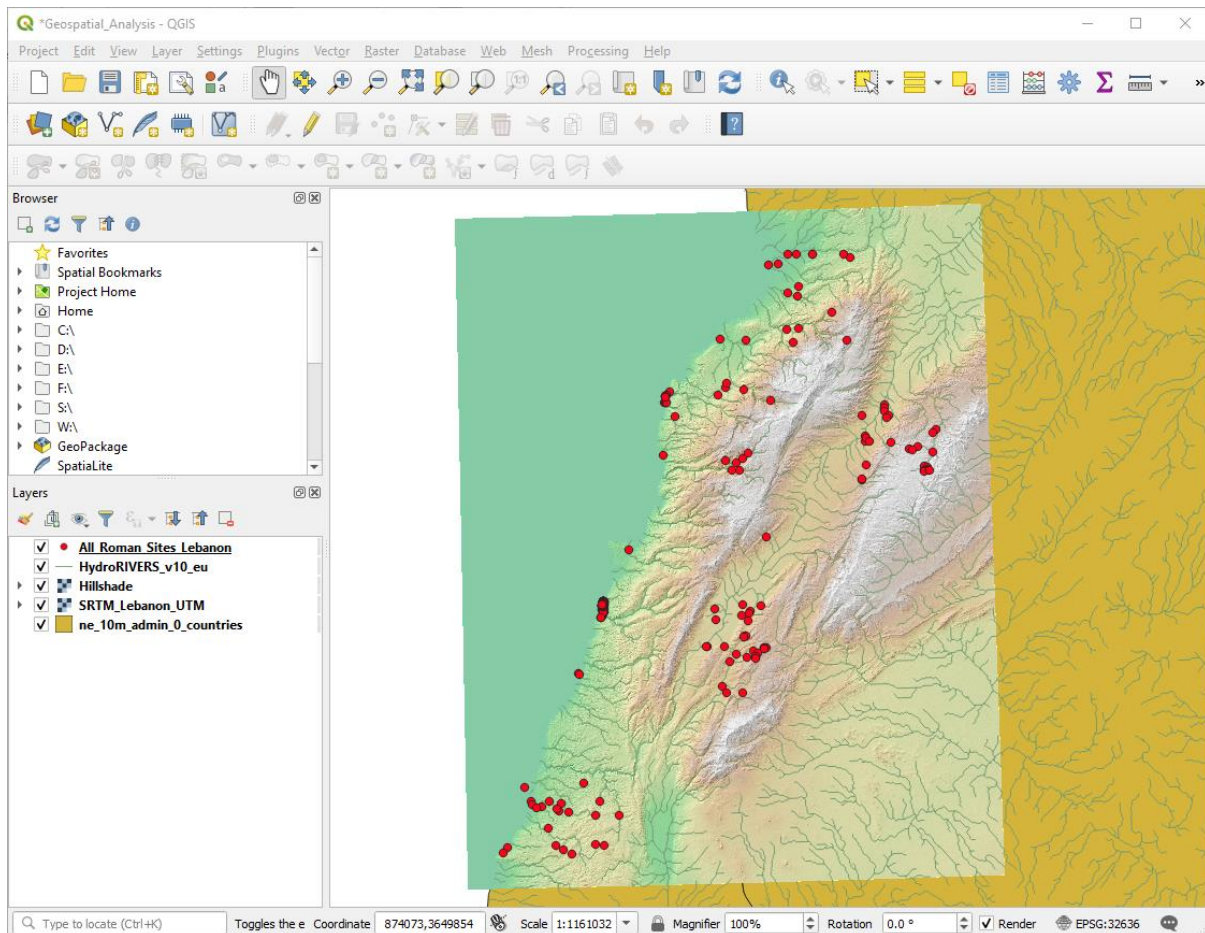
- Click “Download” again on the new page that opens.



HydroRIVERS\_v10\_eu\_shp.zip - 64.5 MB

Download

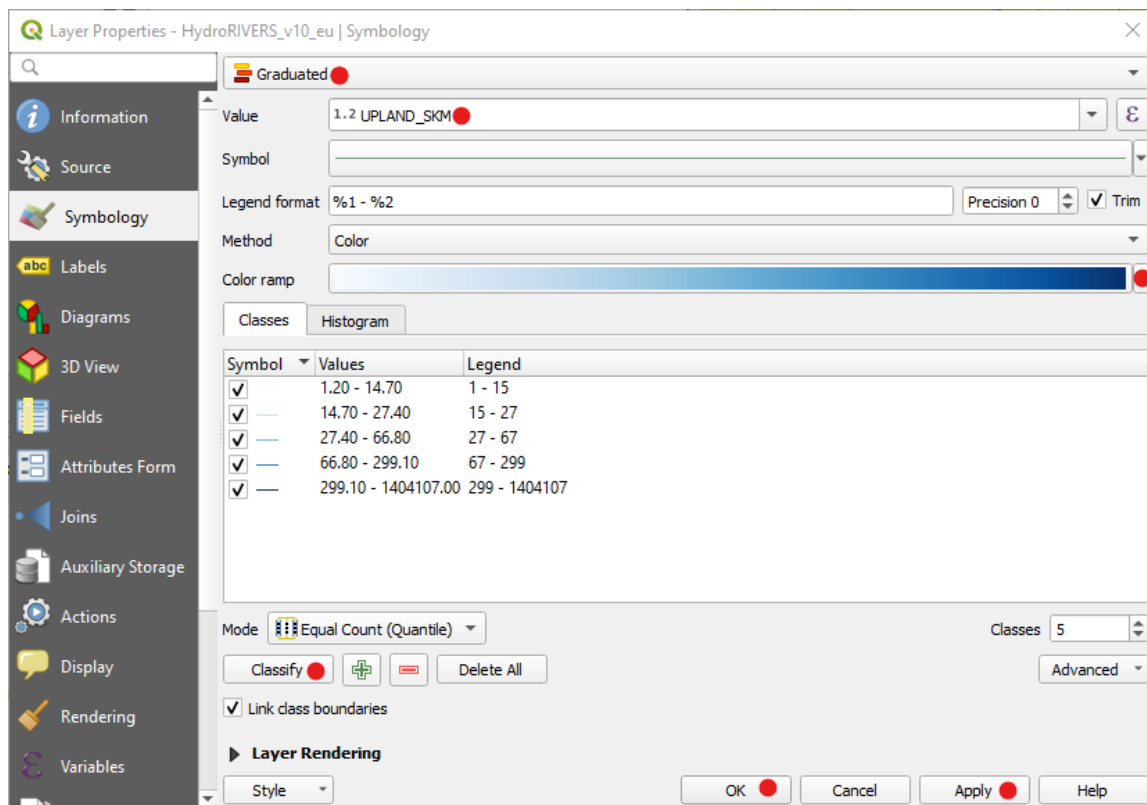
- Allow the zip file to finish downloading. When it is done, move it into your “GIS/Geospatial” folder.
- Right-click the file and select “7-Zip” > “Extract Here” (or another un-archiver program).
- In QGIS use the Open Data Source Manager button to add the new shapefile inside the folder.



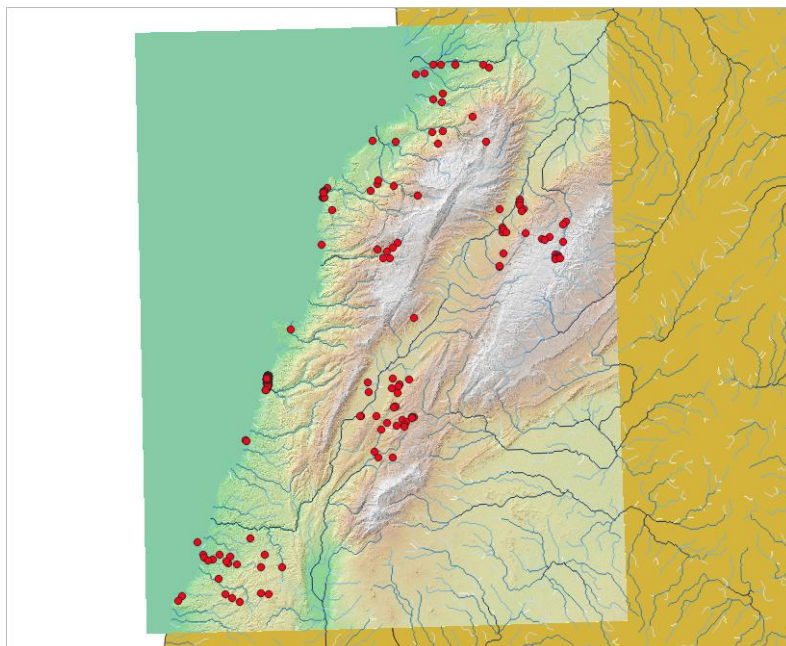


We could make all the rivers look the same, but it would be better to show their relative size.

- Right click the HydroRIVERS shapefile and select “Properties”.
- Click on the Symbology tab.
- Change “Single Symbol” to “Graduated”.
- Change “Value” to “UPLAND\_SKM”.
- Change the Colour ramp to a suitable blue one.
- Click the “Classify” button then Apply and OK.



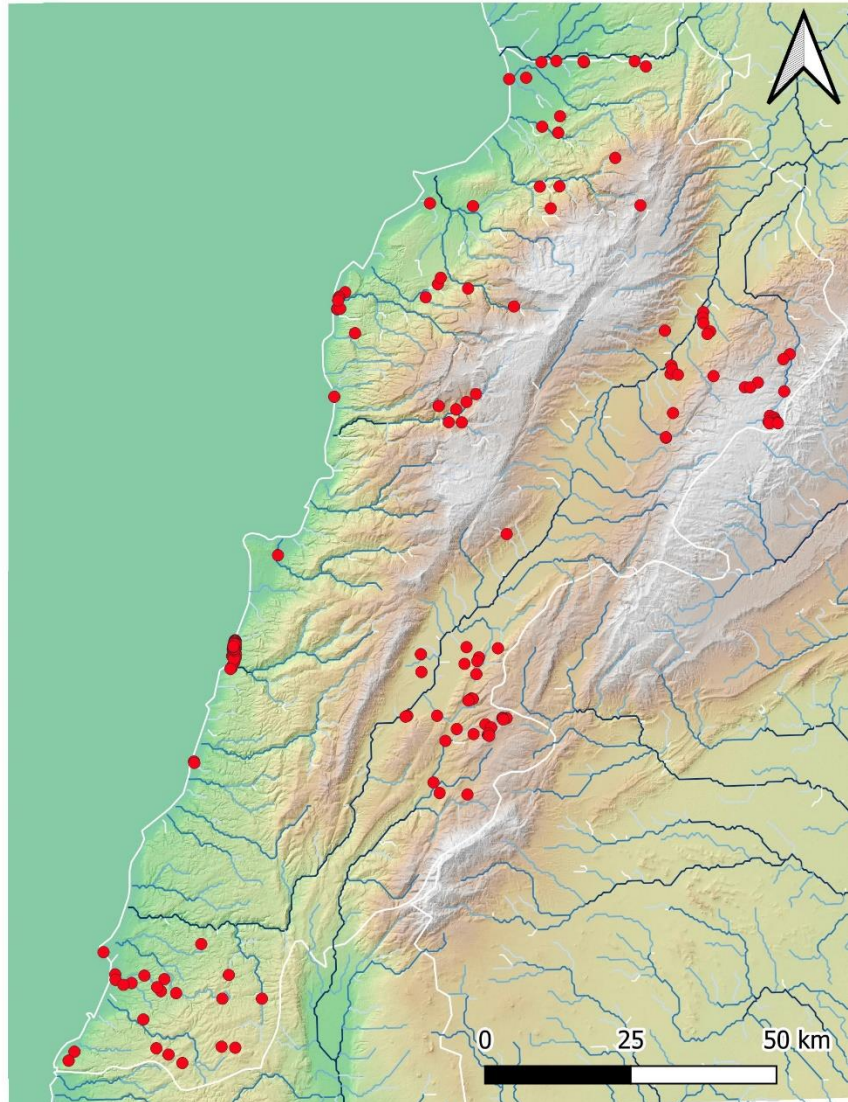
The rivers will now have a different shade depending on the size of their catchment area.



**PRACTICE:** create a topographical map of your area of interest using this data.

### Roman Sites and Topography in Lebanon

- Roman sites
- Rivers (catchment area, sq-km)
  - 1 - 15
  - 15 - 27
  - 27 - 67
  - 67 - 299
  - 300+
- Elevation (m)
  - 0
  - 500
  - 1000
  - 1500
  - 2000
  - 2500



## 2 Elevation and Hydrological Geospatial Analysis (video tutorial playlist)

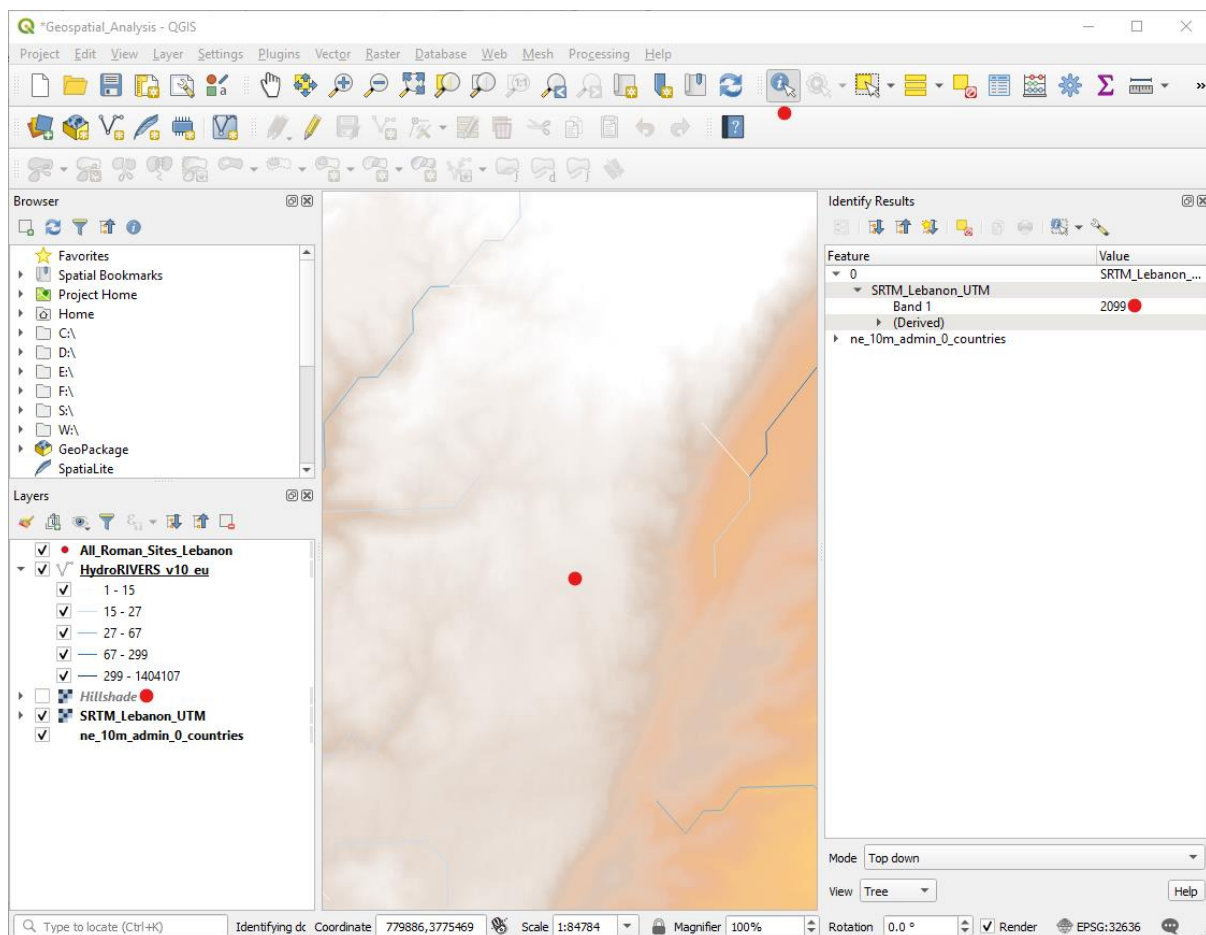
Having downloaded the elevation and hydrological data that we need from the internet, we are now going to use it to carry out some simple geospatial analysis in order to find out more about our sites. We are going to calculate the elevation of all of our sites and how far they are from the nearest watercourse.

### 2.1 Extracting elevation values (video tutorial)

It is possible to read the elevation values of any particular area, including for our sites.

- On the Toolbar click the Identify Features button.
- Turn off the Hillshade layer and then click anywhere on the SRTM raster.

The Identify Results Panel will open and next to “Band 1” you will see the elevation of the pixel that you clicked on.



- Find one of your sites and click on it using the “Identify Features” button



You will see lots of information about your site from the database.

- Scroll down in the results and at the bottom you will see your SRTM raster.
- Expand this twice and you will see the elevation value for the site.

The screenshot shows the QGIS interface with the following components:

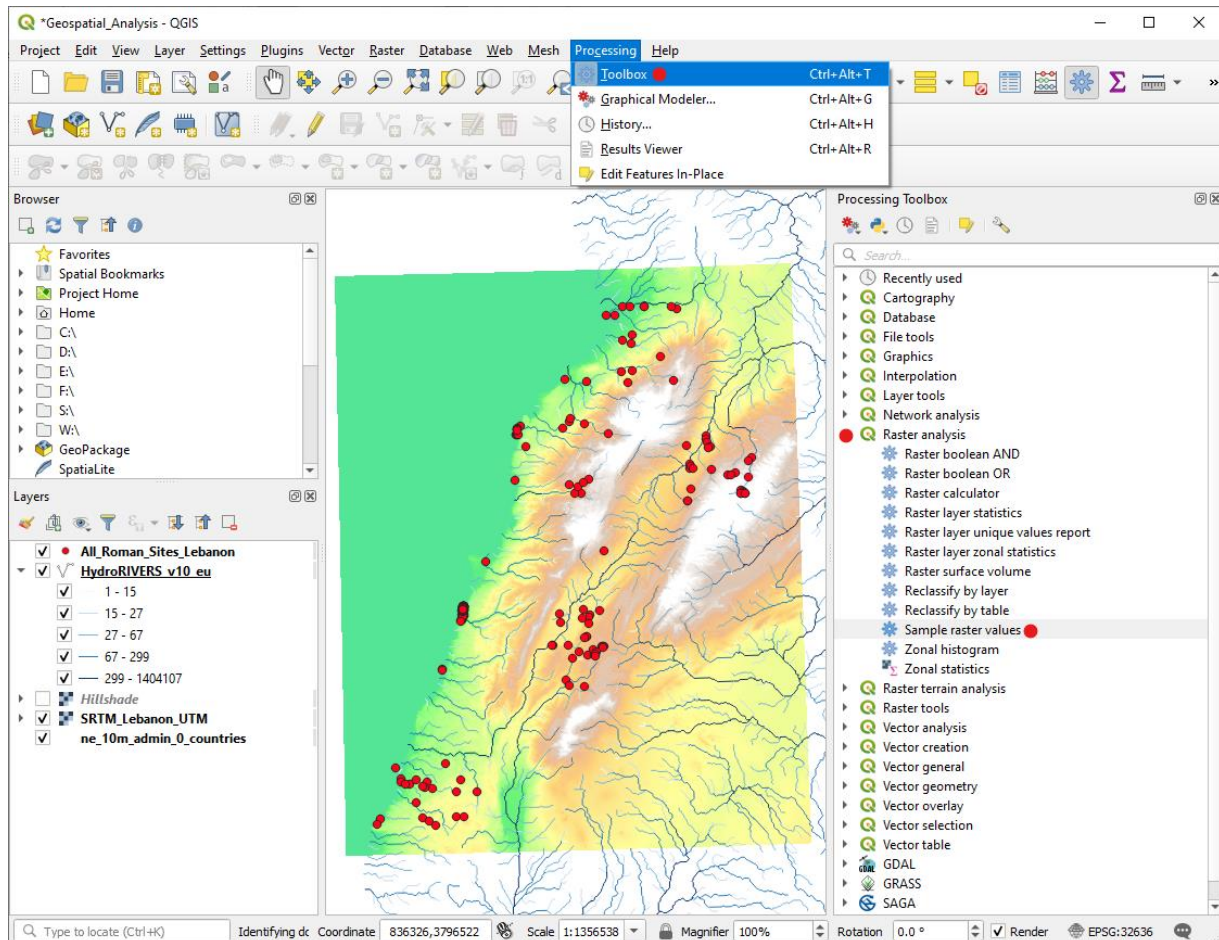
- Browser Panel:** Lists project files and layers. The 'Layers' panel shows:
  - ☒ All\_Roman\_Sites\_Lebanon
  - ☒ HydroRIVERS v10.eu
    - ☒ 1 - 15
    - ☒ 15 - 27
    - ☒ 27 - 67
    - ☒ 67 - 299
    - ☒ 299 - 1404107
  - ☐ Hillshade
  - ☒ SRTM\_Lebanon\_UTM
  - ☒ ne\_10m\_admin\_0\_countries
- Map View:** Displays a hillshade map with a red point indicating the selected location. The status bar shows coordinates: 763421,3777281, Scale: 1:21196, Magnifier: 100%.
- Identify Results Panel:** Shows metadata for the selected point. The table below represents the data shown in this panel:

Feature	Value
Period	Classical/Pre-Isl.
Per_Cert	Definite; Definit.
Form	Object; Structur.
Form_Cert	Definite; High; ...
Arrangemen	Discrete; Discret.
Feature_No	1; 1; 1
Feat_Shape	Sub-rectangula..
Interpreta	Church/Chapel;
Inter_Cert	Definite; Definit.
Inter_No	1; 1; 1
Condition	NULL
Dist_Exten	NULL
Dist_Type	NULL
Dist_Cause	NULL
DistCauseC	NULL
DistDateBe	NULL
DistDateOn	NULL
DistDateFr	NULL
DistDateTo	NULL
DistEffect	NULL
DistEffCer	NULL
ThreatType	NULL
ThreatCaus	NULL
ThrCauseCe	NULL
Desc_Type	NULL
Description	NULL
Assessor	Jennie Bradbury
layer	Centroids
path	Point?crs=EPSG...
1 ●	
SRTM_Lebanon_UTM ●	
Band 1	1326 ●
(Derived)	
ne_10m_admin_0_countries	

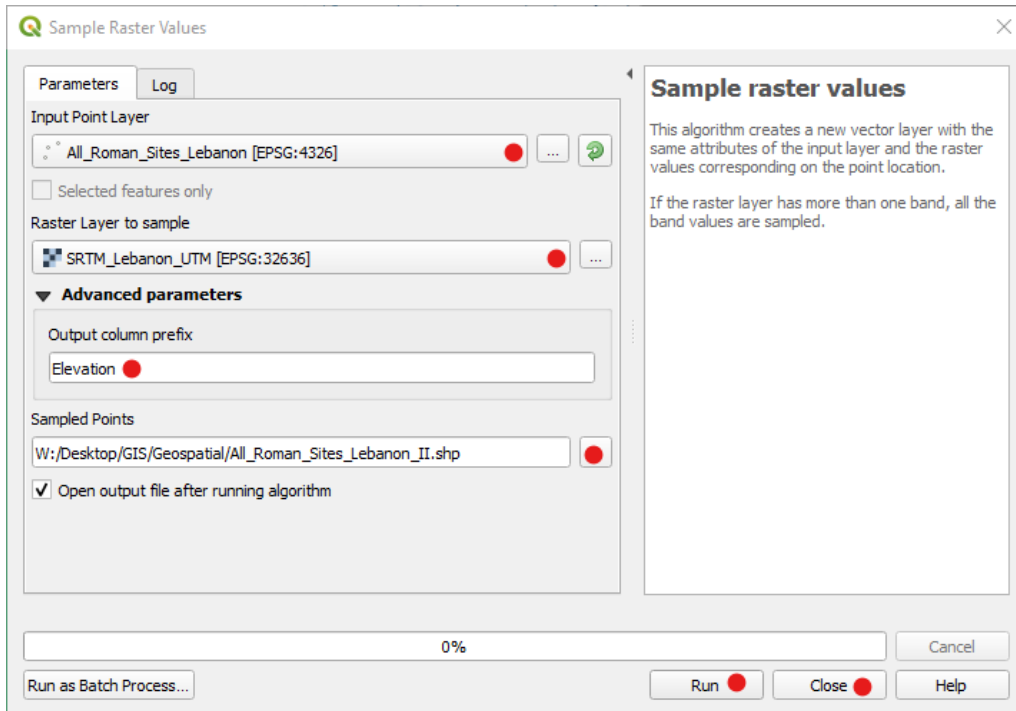
At the bottom of the Identify Results panel, the 'Mode' is set to 'Top down' and the 'View' is set to 'Tree'.

It would take a long time to do this and record the result for every site, so there is also an automatic way of achieving this in QGIS.

- Click “Processing” on the Menu and select “Toolbox”.
- Expand “Raster analysis” and double-click on “Sample raster values”.



- For “Input point layer” select your sites.
- For “Raster Layer to sample” select the SRTM raster.
- For “Output column prefix” type “Elevation”.
- For “Sampled points” click the Browse button [...] and “Save to File”.
- Give your new shapefile a name and click “Save”.
- Click Run and then Close when it completes.



Your new shapefile will be added to your Map View and Layers Panel.

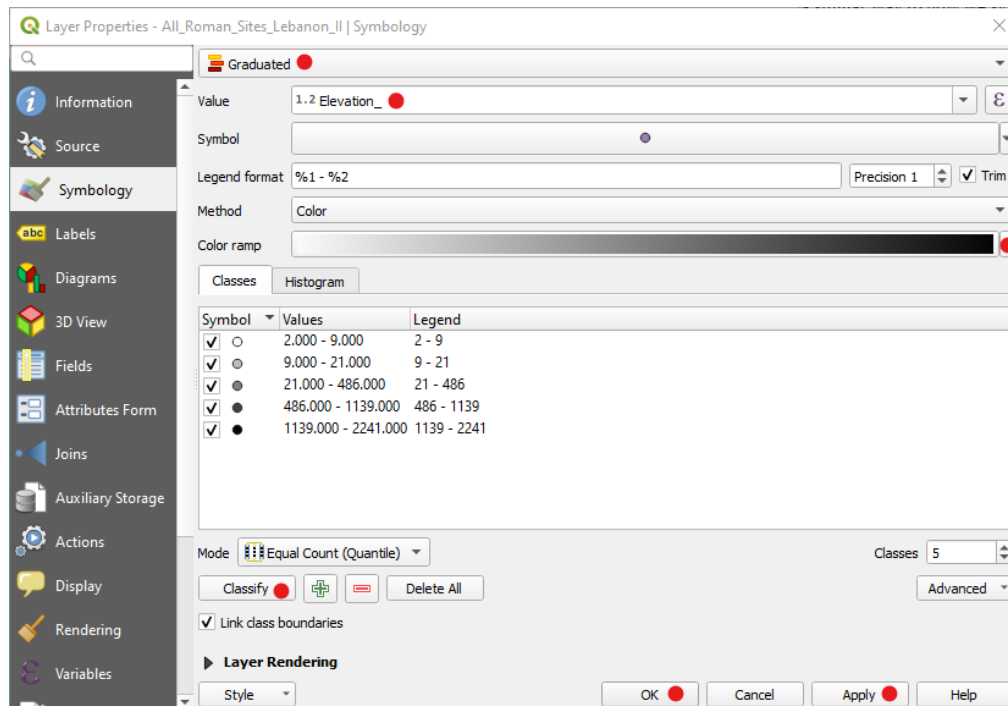
- Right-click it and select “Open Attribute Table”
- Scroll to the last column on the right

You will see that a new “Elevation” column has been added and the elevation of each site has been calculated.

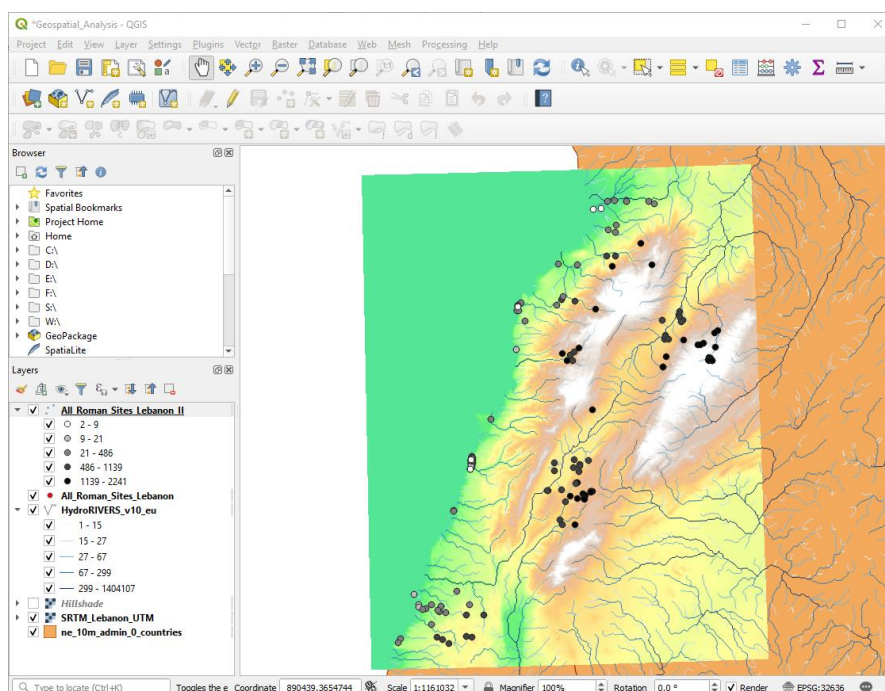
	DistEffect	DistEffCer	ThreatType	ThreatCaus	ThrCauseCe	Desc_Type	Description	Assessor	layer	path	Elevation
1	NULL	NULL	Agricultural/Pa...	Vegetation/Cro...	Planned	Comments	Fieldwalking tra...	Letty Ten Harke...	Centroids	Point?crs=EPSG...	8.000000000000...
2	NULL	NULL	Agricultural/Pa...	Ploughing; Veg...	Planned; Planned	Comments	Fieldwalking tra...	Letty Ten Harke...	Centroids	Point?crs=EPSG...	16.000000000000...
3	NULL	NULL	Agricultural/Pa...	Ploughing; Veg...	Planned; Planned	Comments	Fieldwalking tra...	Letty Ten Harke...	Centroids	Point?crs=EPSG...	8.000000000000...
4	NULL	NULL	Agricultural/Pa...	Ploughing; Veg...	Planned; Planned	Comments	Fieldwalking tra...	Letty Ten Harke...	Centroids	Point?crs=EPSG...	5.000000000000...
5	NULL	NULL	NULL	NULL	NULL	NULL	NULL	Letty Ten Harkel	Centroids	Point?crs=EPSG...	1384.0000000000...
6	NULL	NULL	NULL	NULL	NULL	NULL	NULL	Letty Ten Harkel	Centroids	Point?crs=EPSG...	1447.0000000000...
7	NULL	NULL	NULL	NULL	NULL	NULL	NULL	Pascal Flohr	Centroids	Point?crs=EPSG...	1223.0000000000...
8	NULL	NULL	NULL	NULL	NULL	NULL	NULL	Pascal Flohr	Centroids	Point?crs=EPSG...	1152.0000000000...
9	NULL	NULL	NULL	NULL	NULL	NULL	NULL	Letty Ten Harkel	Centroids	Point?crs=EPSG...	1411.0000000000...
10	NULL	NULL	NULL	NULL	NULL	NULL	NULL	Letty Ten Harkel	Centroids	Point?crs=EPSG...	1487.0000000000...
11	NULL	NULL	NULL	NULL	NULL	NULL	NULL	Letty Ten Harkel	Centroids	Point?crs=EPSG...	1370.0000000000...
12	NULL	NULL	NULL	NULL	NULL	NULL	NULL	Letty Ten Harkel	Centroids	Point?crs=EPSG...	1418.0000000000...
13	NULL	NULL	Domestic Use	Occupation/Co...	Probable	NULL	NULL	Letty Ten Harke...	Centroids	Point?crs=EPSG...	13.000000000000...
14	NULL	NULL	Domestic Use	Occupation/Co...	Probable	NULL	NULL	Letty Ten Harkel	Centroids	Point?crs=EPSG...	114.0000000000...
15	NULL	NULL	Agricultural/Pa...	Construction; V...	Possible; Proba...	NULL	NULL	Letty Ten Harke...	Centroids	Point?crs=EPSG...	81.000000000000...
16	NULL	NULL	Building and D...	Construction	Possible	NULL	NULL	Letty Ten Harke...	Centroids	Point?crs=EPSG...	55.000000000000...
17	NULL	NULL	NULL	NULL	NULL	NULL	NULL	Pascal Flohr	Centroids	Point?crs=EPSG...	501.0000000000...
18	NULL	NULL	NULL	NULL	NULL	NULL	NULL	Pascal Flohr	Centroids	Point?crs=EPSG...	612.0000000000...

We can show this information on the map in a similar way to how we symbolised the rivers.

- Right-click your new sites shapefile and select “Properties”.
- Click on the Symbology tab and change “Single symbol” to “Graduated”.
- Change “Value” to “Elevation”.
- Pick a colour ramp that you like.
- Click “Classify” and then Apply and OK.



Your sites will now be coloured according to their elevation.

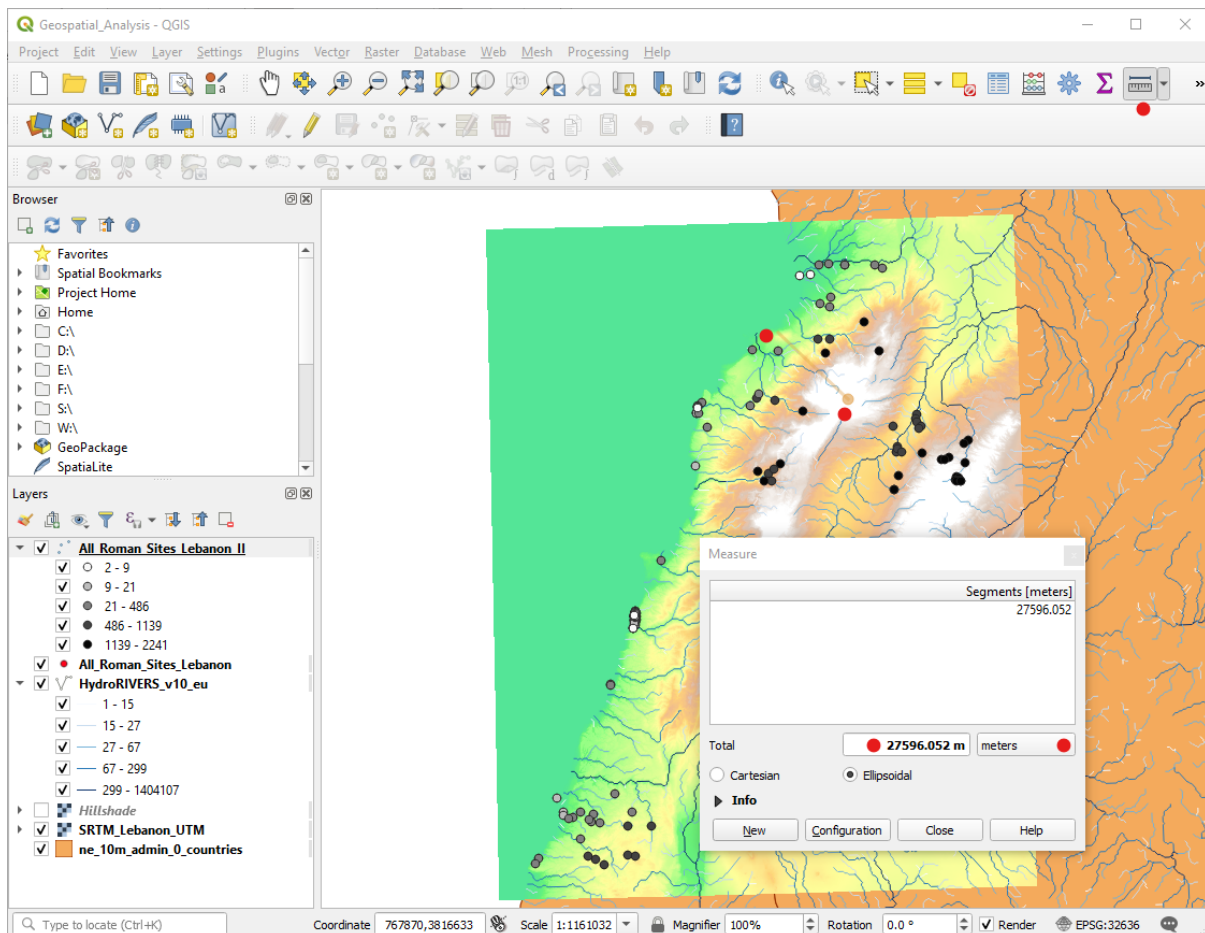


- Remove the old shapefile from the Layers Panel by right-clicking and selecting “Remove layer”

## 2.2 Measuring distance (video tutorial)

In a similar way, it is possible to measure the distance between features in QGIS, for example the distance between our sites and the nearest river.

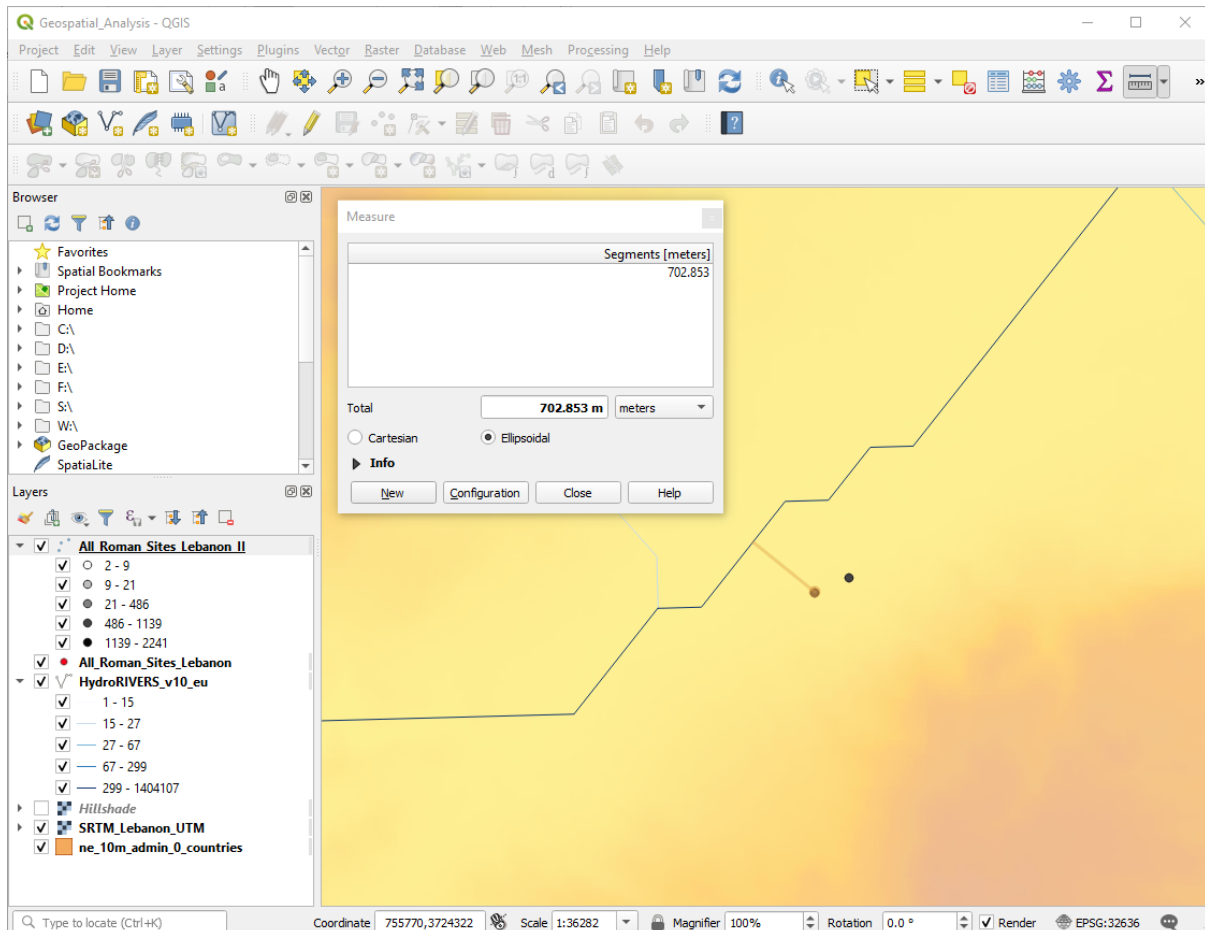
- On the Toolbar click the Measure Line button.
- Click between any two points on the map to measure the distance between them.
- You can also change the units if this is helpful.





You could use this to measure the distance between two sites, or between a site and the nearest river.

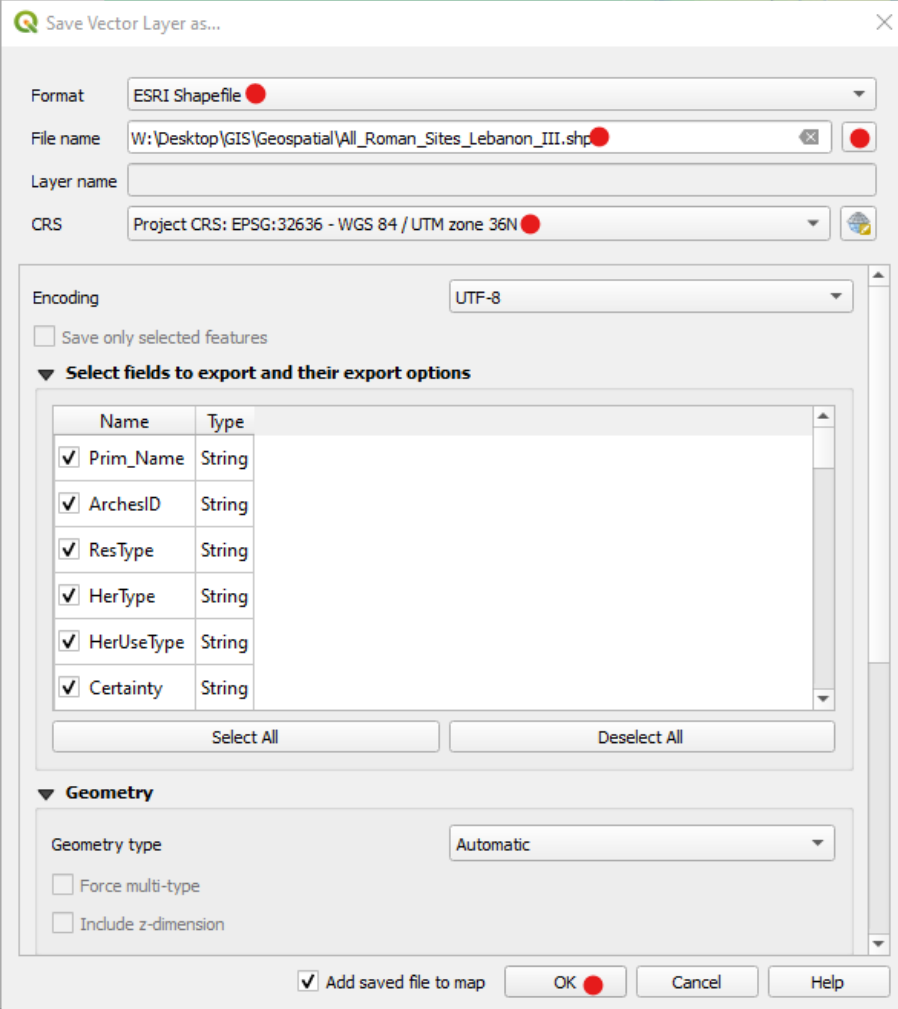
- Zoom into a site and its nearest river.
- Click the Measure Line button and then click on the site and the nearest section of the river.



This will measure the distance between the site and the river. Just like with the elevation task, there is a way that we can automate this for every site.

First, we must make sure that all our relevant data is in UTM format so that distances are measured in metres rather than decimal degrees.

- Right-click your sites shapefile and select “Export” > “Save Sites As”.
- Make sure “Format” is “ESRI Shapefile”.
- Under “File name” click the Browse button [...] and save a new version of your file.
- For “CRS” select “Project CRS”, making sure that this is your UTM zone.
- Everything else can stay the same, so click OK.



Save Vector Layer as...

Format: ESRI Shapefile

File name: W:\Desktop\GIS\Geospatial\All\_Roman\_Sites\_Lebanon\_III.shp

Layer name:

CRS: Project CRS: EPSG:32636 - WGS 84 / UTM zone 36N

Encoding: UTF-8

☐ Save only selected features

▼ Select fields to export and their export options

Name	Type
<input checked="" type="checkbox"/> Prim_Name	String
<input checked="" type="checkbox"/> ArchesID	String
<input checked="" type="checkbox"/> ResType	String
<input checked="" type="checkbox"/> HerType	String
<input checked="" type="checkbox"/> HerUseType	String
<input checked="" type="checkbox"/> Certainty	String

Select All Deselect All

▼ Geometry

Geometry type: Automatic

☐ Force multi-type

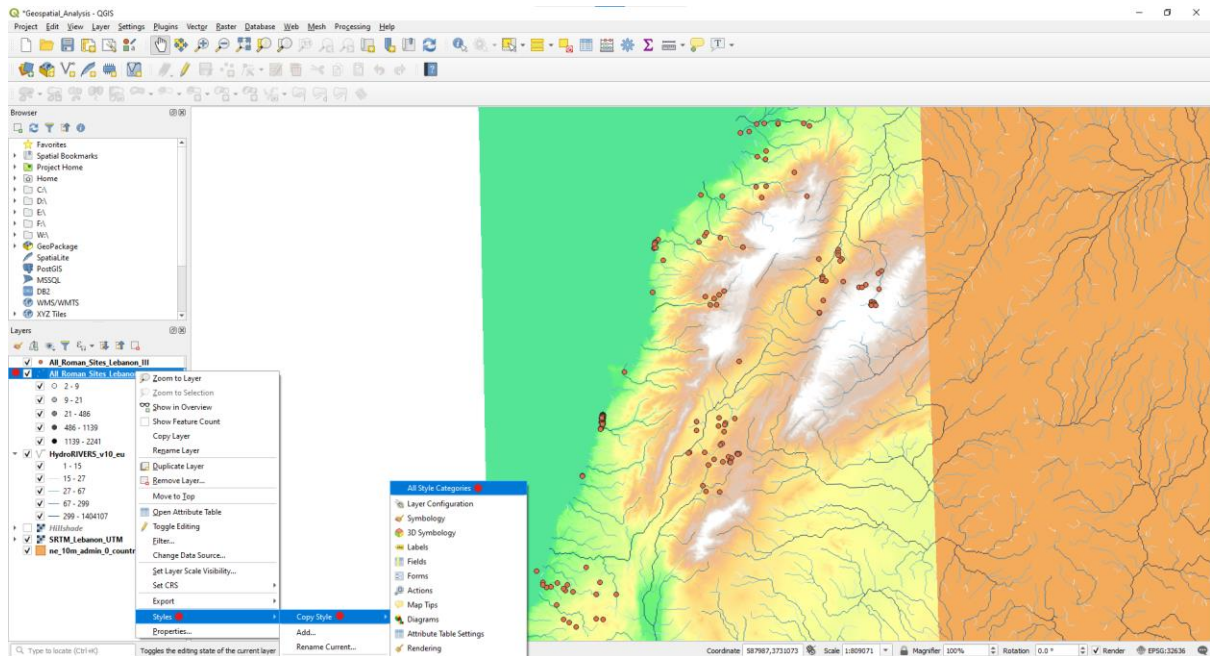
☐ Include z-dimension

☒ Add saved file to map

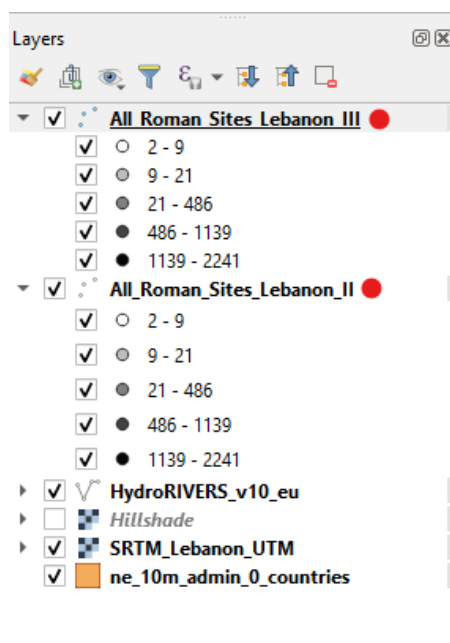
OK Cancel Help

A new version of your file will be added to the Layers Panel and the Map View. However, it will have very basic formatting, so we are going to copy and paste the symbology from the old file before we remove it from the map.

- Right-click your old shapefile and select “Styles” > “Copy Style” > “All Style Categories”.
- Right-click your new shapefile and select “Styles” > “Paste Style” > “All Style Categories”.



Your new shapefile should now look identical to the old one, so you can now remove the old file.





Now we need to do something similar with the HydroRIVERS shapefile. However, in order to speed up the automatic measuring step, we are also going to just extract part of the file to make it smaller.

- In the Map View, zoom in to the area that you want to trim the rivers shapefile to.
  - The easiest way of doing this for your area of interest is to “Zoom to Layer” on your SRTM raster.
- Open the HydroRIVERS Attribute Table.
- Click the “Show All Features” filter button and select “Show Features Visible on Map”.
- Click the row number on the left side next to the first feature at the top of the table.
- Scroll down to the bottom, hold the shift key and click the row number next to the last feature to select all of the visible features.

HydroRIVERS\_v10\_eu :: Features Total: 938544, Filtered: 1535, Selected: 1535

	HYRIV_ID	NEXT_DOWN	MAIN_RIV	LENGTH_KM	DIST_DN_KM	DIST_UP_KM	CATCH_SKM	UPLAND_SKM	ENDORHEIC
1518	20741220	20740742	20737602	4.73	36.9	15.3	7.38	34.6	
1519	20741223	20740283	20739158	10.23	12.5	52.3	31.88	279.9	
1520	20741292	20741620	20765143	7.13	184.3	13.5	27.36	27.4	
1521	20741293	20741620	20765143	10.69	184.3	18.5	32.58	32.6	
1522	20741294	20741490	20765143	14.65	185.1	19.6	50.41	50.4	
1523	20741295	20741490	20765143	9.45	185.1	16.4	28.63	28.6	
1524	20741296	20740470	20739158	7.31	39.4	13.0	45.03	45.0	
1525	20741425	20741757	20765143	5.66	232.9	30.3	22.15	136.8	
1526	20741426	20742504	20765143	8.38	242.9	14.9	41.59	41.6	
1527	20741550	20739932	20739158	15.89	18.1	28.3	32.23	70.8	
1528	20741621	20742332	20765143	17.03	181.4	25.6	44.64	83.1	
1529	20741691	20741915	20765143	9.76	182.9	12.9	55.64	55.6	
1530	20741760	20740742	20737602	7.80	36.9	38.6	18.19	174.9	
1531	20742204	20742502	20765143	16.77	226.9	23.1	47.54	47.5	
1532	20742206	20740401	20739158	18.77	14.1	27.4	59.27	87.8	
1533	20742331	20742939	20765143	13.08	173.2	105.9	59.27	1615.6	
1534	20742409	20740540	20735351	14.58	68.6	20.7	57.30	57.3	
1535	20743295	20743638	20765143	22.42	212.2	27.7	68.82	68.8	

Show Features Visible On Map

- Close the Attribute Table.
- Right-click the shapefile in the Layers Panel and select “Export” > “Save Selected Features”.
- For “Format” select “ESRI Shapefile”.
- Click the Browse button [...] and give the new shapefile a name.
- Make sure that for “CRS”, you have selected “Project CRS” and that this matches your UTM zone.
- Click OK.

Save Vector Layer as...

Format: ESRI Shapefile

File name: W:\Desktop\GIS\Geospatial\HydroRIVERS\_v10\_eu\_shp\HydroRIVERS\_v10\_eu\_UTM.shp

Layer name:

CRS: Project CRS: EPSG:32636 - WGS 84 / UTM zone 36N

Encoding: UTF-8

☒ Save only selected features

▼ Select fields to export and their export options

Name	Type	Replace with displayed values
<input checked="" type="checkbox"/> HYRIV_ID	Integer	<input type="checkbox"/> Use Range
<input checked="" type="checkbox"/> NEXT_DOWN	Integer	<input type="checkbox"/> Use Range
<input checked="" type="checkbox"/> MAIN_RIV	Integer	<input type="checkbox"/> Use Range
<input checked="" type="checkbox"/> LENGTH_KM	Real	
<input checked="" type="checkbox"/> DIST_DN_KM	Real	
<input checked="" type="checkbox"/> DIST_UP_KM	Real	

Select All Deselect All

☐ Replace all selected raw field values by displayed values

▼ Geometry

Geometry type: Automatic

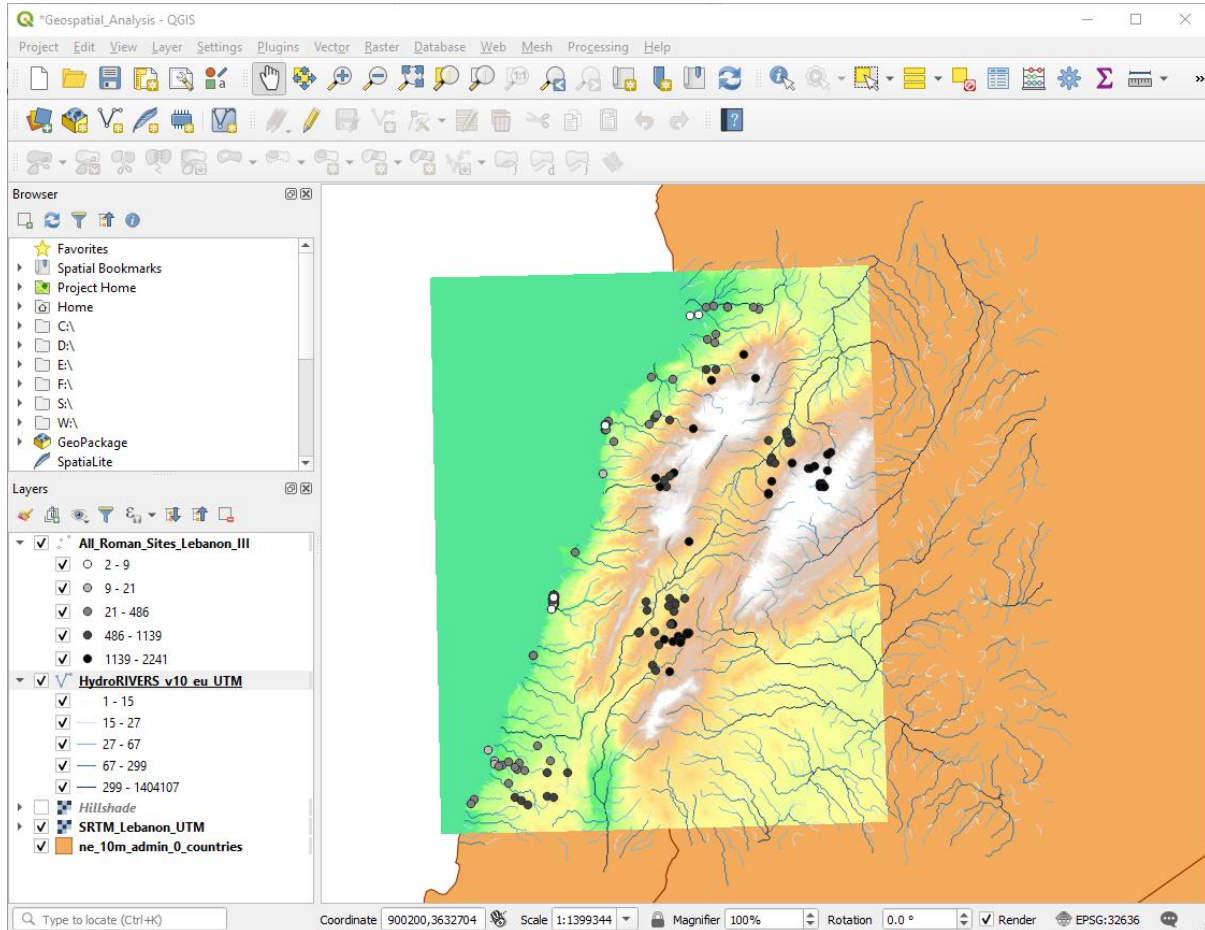
☐ Force multi-type

☒ Add saved file to map

OK Cancel Help

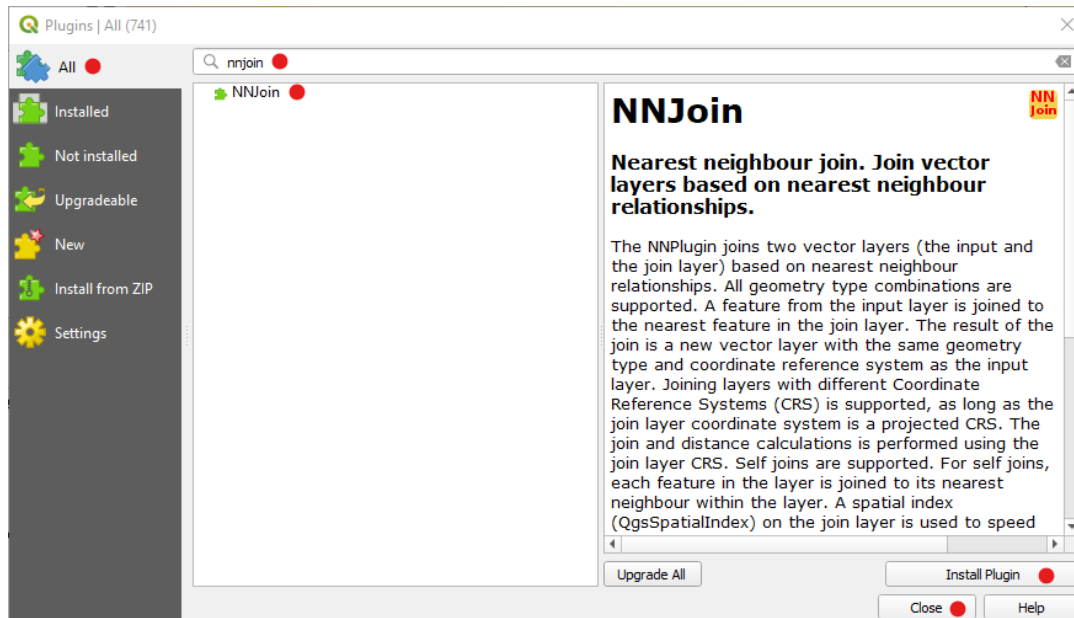
A new, unformatted shapefile of the rivers in your area of interest will be added to the Layers Panel and Map View.

- Copy and paste the symbology from the old shapefile to the new version.
- Remove the old shapefile.

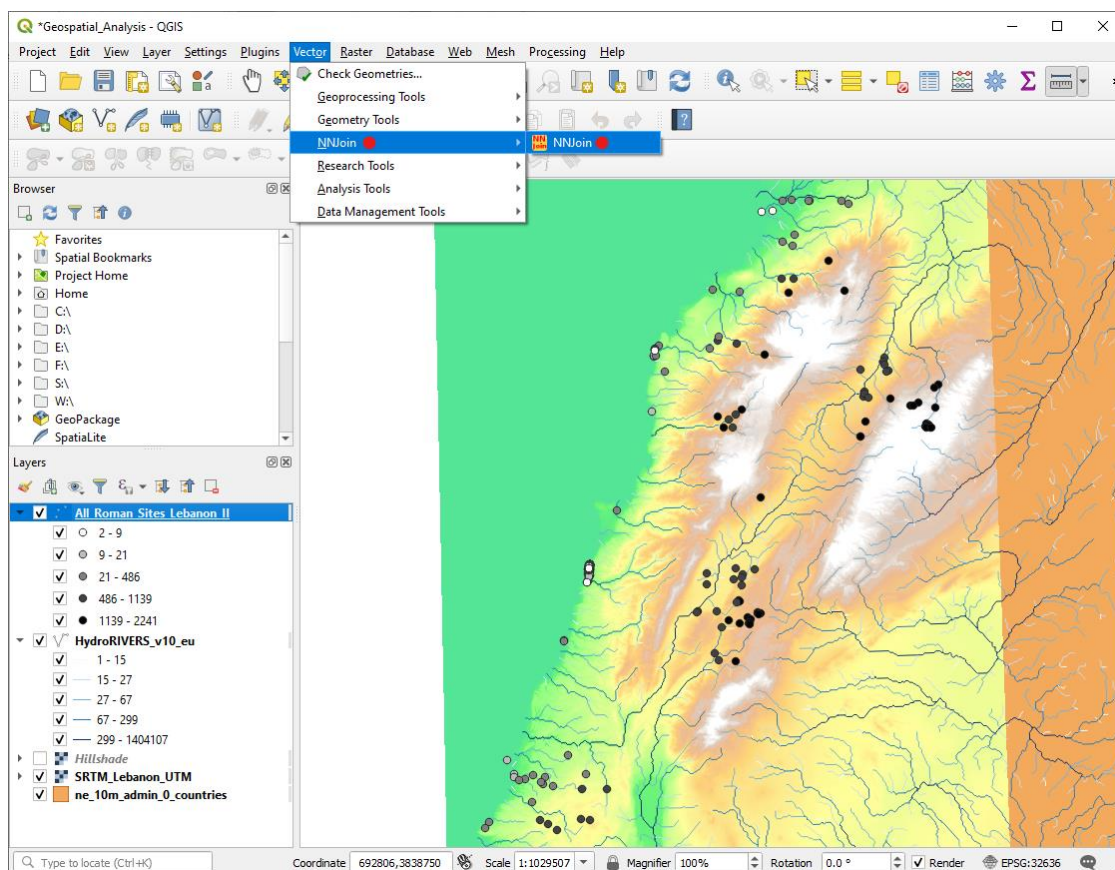


Finally, to automatically measure the distances we need to install a “Plugin” – an extra tool that is not part of the main QGIS software but which runs inside it.

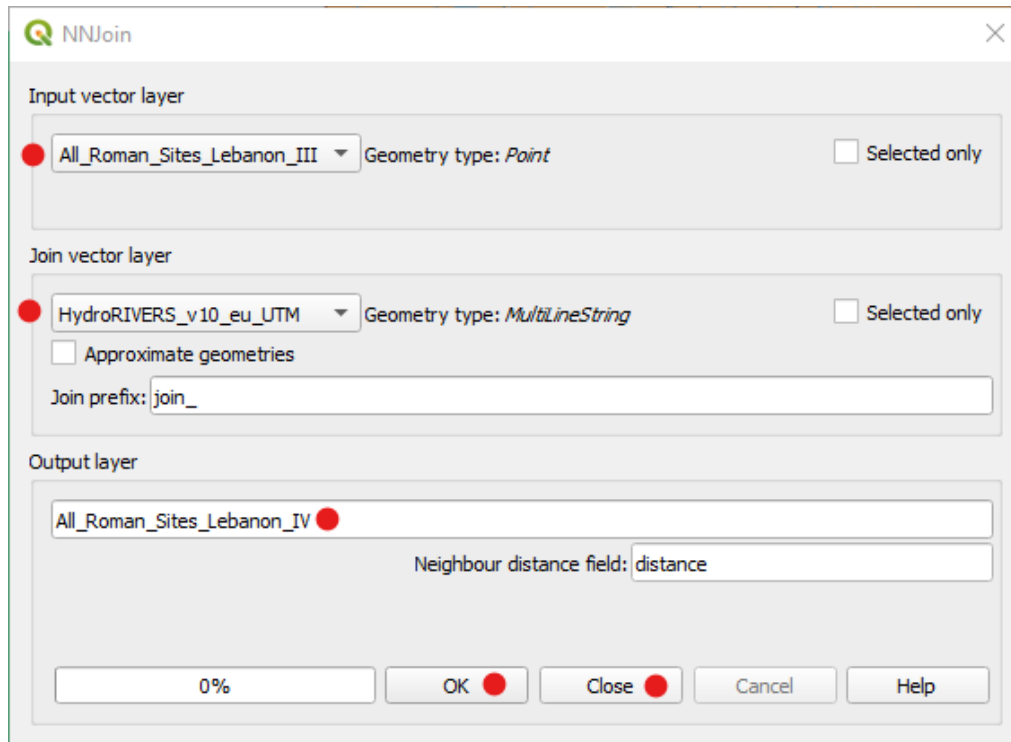
- On the Menu click “Plugins” > “Manage and install plugins”.
- Click the All tab.
- Type “nnjoin” into the search box.
- Click “NNJoin” and then Install Plugin and then Close when it completes.



- On the Menu click “Vector” > “NNJoin” > “NNJoin”.



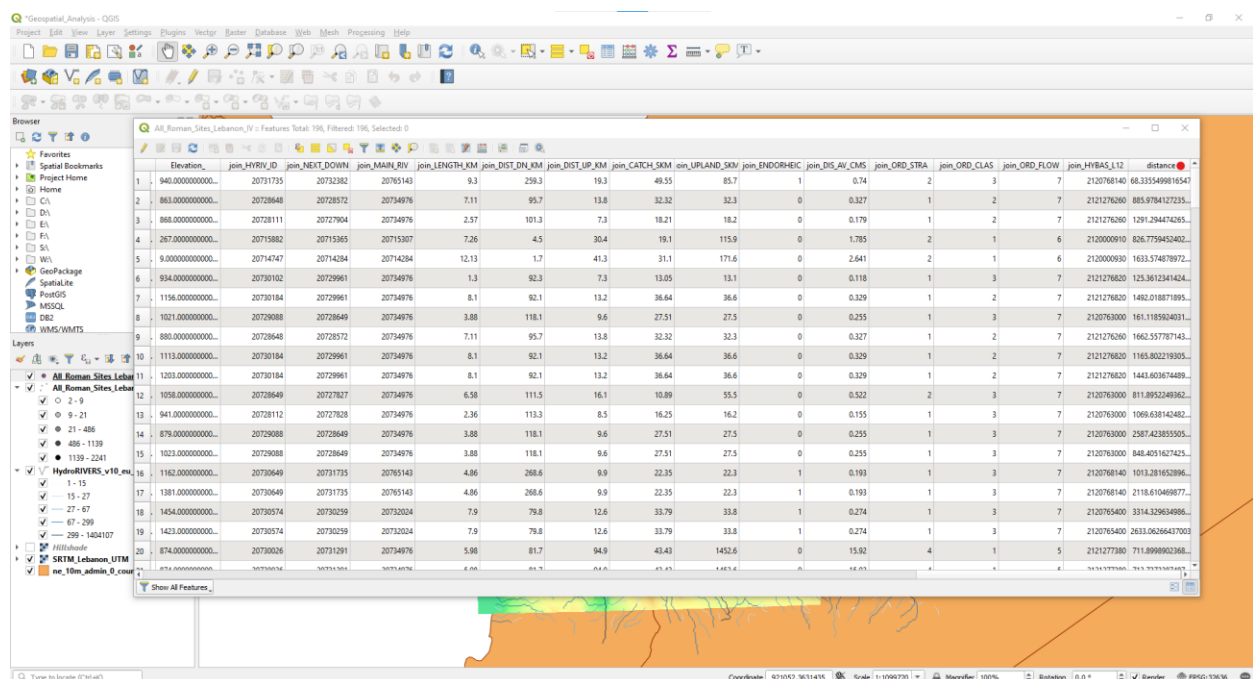
- For “Input vector layer” select your sites shapefile.
- For “Join vector layer” select the HydroRIVERS shapefile.
- For “Output layer” give your new file a useful name then click OK and Close when finished.



A new layer will be added to QGIS.

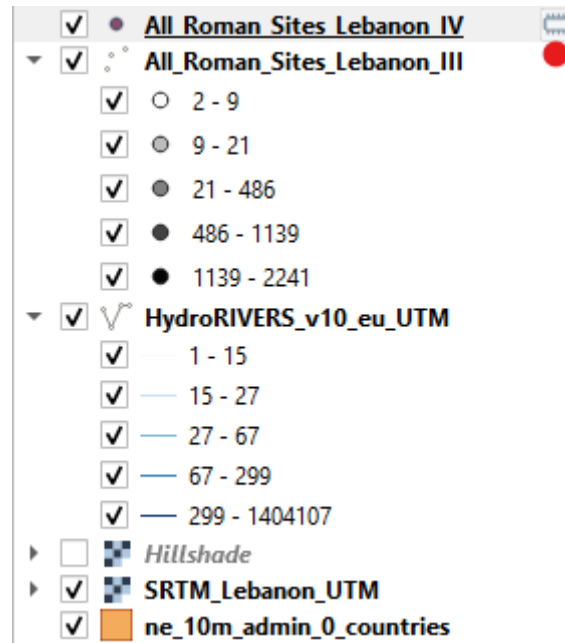
- Open the new layer’s Attribute Table.

You will notice that as well as elevation, it now also contains all the details of the closest river to each site including, in the last column, the distance between them, in metres.



The NNJoin plugin works a little bit differently to other tools – it doesn't save the results permanently, so we have to tell it to do this.

- If you look next to your new sites layer you will see a little computer chip icon – this tells us that it is a temporary file.

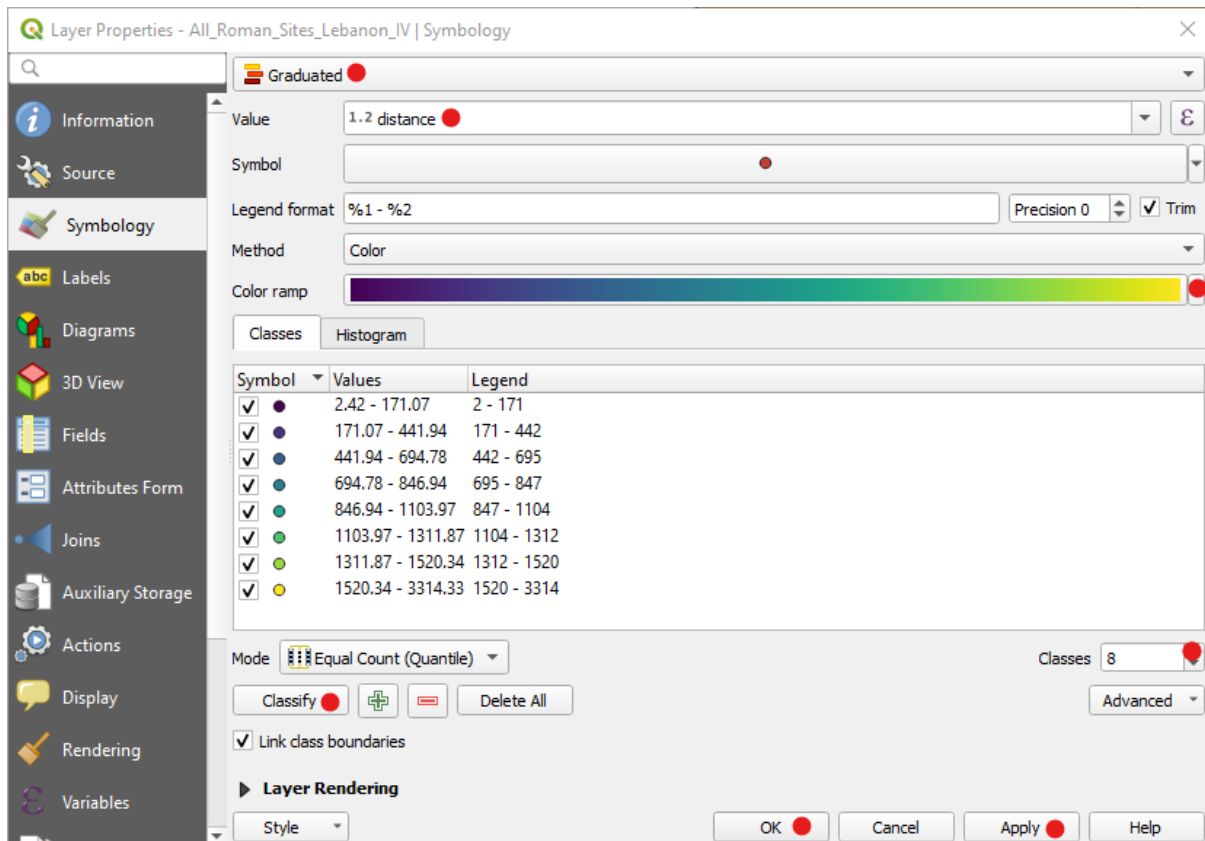


- Right-click this file and select “Make Permanent”.
- Save it as a shapefile in your Geospatial folder with the other files.

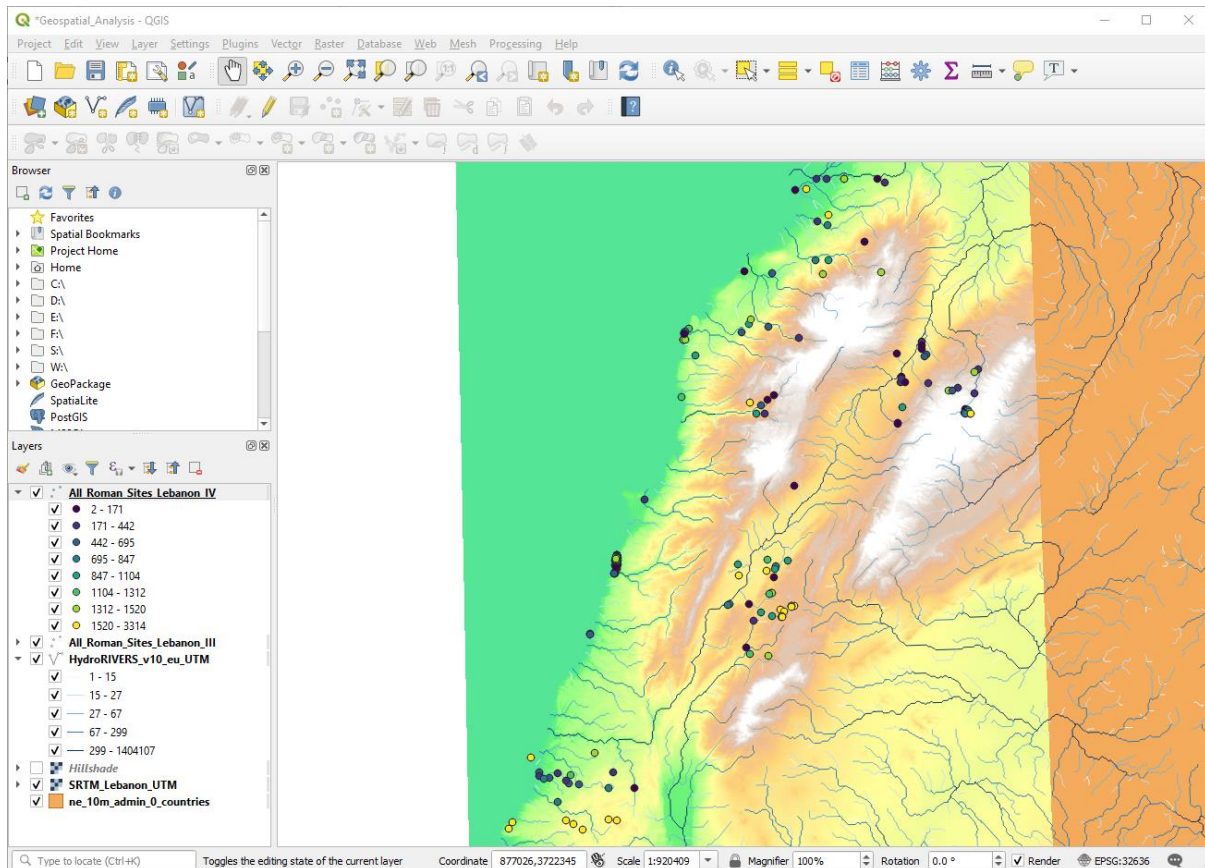


Just as with elevation we can show the distance of each site to its nearest river on our map.

- Right-click your new shapefile and select “Properties”.
- Click on the Symbology tab and change “Single symbol” to “Graduated”.
- Change “Value” to “distance” (right at the bottom of the list).
- Choose a suitable colour ramp.
- If you increase the number of classes more variation in the colours will become visible.



These will now be visible on your map.



## 2.3 Using filtering to analyse different groups of sites (video tutorial)

Now that we have all of this new geospatial information about our sites, we want to be able to use it to better understand them. We are going to do this by asking and answering our own questions about the sites using filtering and statistics in QGIS.

For my example I am going to ask two questions about my data:

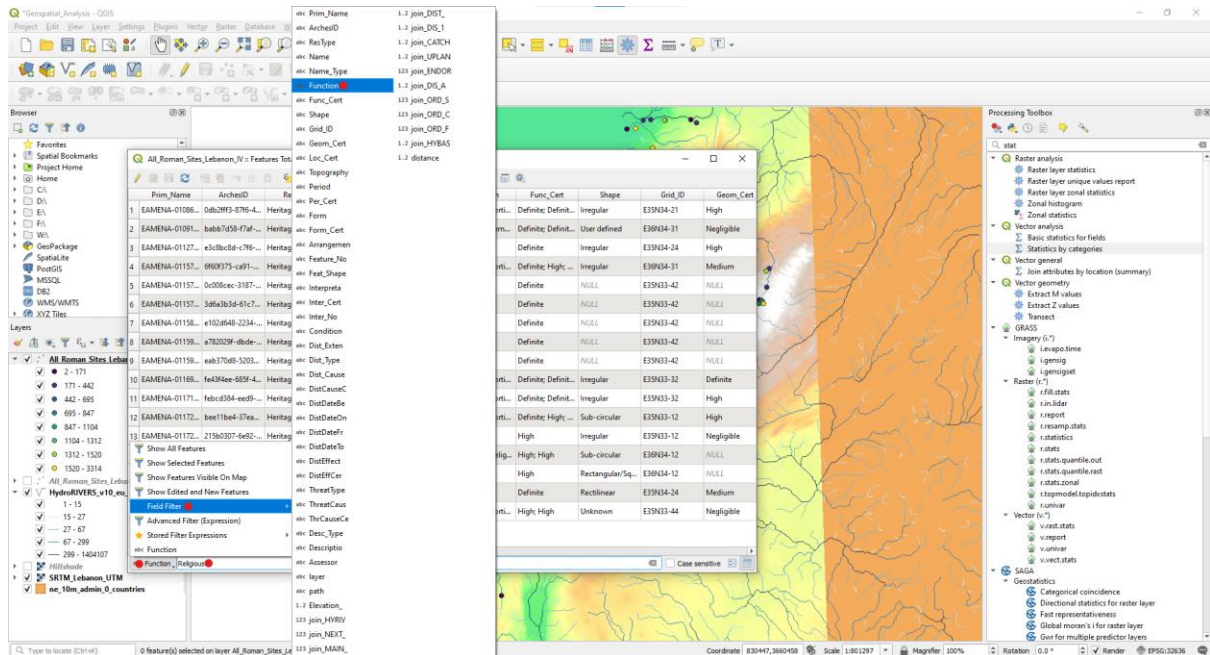
- 1) Are Roman religious sites located in higher positions than other Roman sites?
- 2) Are Roman settlements located closer to rivers and streams than other Roman sites?

You will need to come up with your own questions, but these are two good examples to demonstrate the general method.



We are going to create two new fields in our attribute table, “Religious” and “Settlement”, to mark the relevant records.

- Right-click the sites shapefile and select “Open Attribute Table”.
- Click the filter “Show All Features” button.
- Select “Field Filter” > “Function”.
- In the bottom box type “Religious” and press enter.



The screenshot shows the QGIS interface with the 'All Roman Sites Lebanon' layer selected in the Layers panel. The attribute table is open, and the 'Field Filter' dialog is displayed. The 'Function' tab is selected, and the 'Function' field is set to 'Religious'. The 'Field Filter' dialog also shows the 'Show All Features' button.

Prim_Name	ArchaeoID	Religious
EAMENA-0108...	0db2f58-876-4...	Religious
EAMENA-0112...	6b6b758-c76-4...	Religious
EAMENA-0117...	660975-c81-4...	Religious
EAMENA-0115...	0c088c-3187-...	Religious
EAMENA-0115...	3d62b34-61c7-...	Religious
EAMENA-0115...	e102a548-234-...	Religious
EAMENA-0115...	a76202f-d8de-...	Religious
EAMENA-0115...	eab3748-5203-...	Religious
EAMENA-0116...	fe3f4ee-683f-4...	Religious
EAMENA-0117...	feb3d34-ee09-...	Religious
EAMENA-0117...	bee11b4-37ee-...	Religious
EAMENA-0117...	2196037-6e92-...	Religious

You will see that the attribute table now only includes 17 records that contain the word “Religious” in the “Function” field.

QGIS All\_Roman\_Sites\_Lebanon\_IV :: Features Total: 196, Filtered: 17, Selected: 0

	Prim_Name	ArchesID	ResType	Name	Name_Type	Function	Func_Cert	
1	EAMENA-01086...	0db2ff3-87f6-4...	Heritage Place	Asmar Jbeil; DA...	Alternative Refe...	Defensive/Fortification; Domestic; Industrial/Productive; Religious;	Definite; Definit...	Irr
2	EAMENA-01091...	babb7d58-f7af-...	Heritage Place	E36N34-31_000...	Alternative Refe...	Funerary/Memorial; Religious; Unknown	Definite; Definit...	Us
3	EAMENA-01127...	e3c8bc8d-c7f6-...	Heritage Place	AA'n Akrine; E3...	Alternative Refe...	Religious	Definite	Irr
4	EAMENA-01157...	6f60f375-ca91-...	Heritage Place	Akk9805; E36N3...	Alternative Refe...	Defensive/Fortification; Domestic; Religious	Definite; High; ...	Irr
5	EAMENA-01157...	0c008cec-3187-...	Heritage Place	Ayn Labwa; Cro...	Alternative Refe...	Religious	Definite	NO
6	EAMENA-01157...	3d6a3b3d-61c7...	Heritage Place	Aaqbe; Crow...	Alternative Refe...	Religious	Definite	NO
7	EAMENA-01158...	e102d648-2234-...	Heritage Place	E35N33-42_000...	Alternative Refe...	Religious	Definite	NO
8	EAMENA-01159...	a782029f-dbde-...	Heritage Place	Aaiha; E35N33-...	Alternative Refe...	Religious	Definite	NO
9	EAMENA-01159...	eab370d8-5203...	Heritage Place	Bonatz_2002_36...	Alternative Refe...	Religious	Definite	NO
10	EAMENA-01169...	fe43f4ee-685f-4...	Heritage Place	E35N33-32_000...	Alternative Refe...	Defensive/Fortification; Religious; Trade/Commercial	Definite; Definit...	Irr
11	EAMENA-01171...	febcd384-eed9-...	Heritage Place	Al-Moez Castle;...	Alternative Refe...	Defensive/Fortification; Domestic; Entertainment/Leisure; Military;...	Definite; Definit...	Irr
12	EAMENA-01172...	bee11be4-37ea...	Heritage Place	Castle of Toron;...	Alternative Refe...	Defensive/Fortification; Domestic; Religious; Trade/Commercial	Definite; High; ...	Su
13	EAMENA-01172...	215b0307-6e92-...	Heritage Place	E35N33-12_000...	Alternative Refe...	Religious	High	Irr
14	EAMENA-01176...	fada9671-0c7c-...	Heritage Place	DaA'aat el Aati...	Alternative Refe...	Domestic; Religious	High; High	Su
15	EAMENA-01178...	ba89e0b2-0d69...	Heritage Place	E36N34-12_000...	Alternative Refe...	Religious	High	Re
16	EAMENA-01337...	2ebadad6-655e...	Heritage Place	Beit Aziz; Biziz; ...	Alternative Refe...	Religious	Definite	Re
17	EAMENA-01339...	1ae3a71c-8a1e-...	Heritage Place	Bi'qat Mizpa; D...	Alternative Refe...	Defensive/Fortification; Religious	High; High	Ur

abc Function Religious Case sensitive

We now want to mark these sites so we can easily find them again more easily. We will do this by creating a new field.

- Select all 17 “Religious” sites by selecting the row number next to the first, holding shift, and selecting the row number next to the last site.
- Then click the “Field Calculator” button.

QGIS All\_Roman\_Sites\_Lebanon\_IV :: Features Total: 196, Filtered: 17, Selected: 17

	Prim_Name	ArchesID	ResType	Name	Name_Type	Function	Func_Cert	
1	EAMENA-01086...	0db2ff3-87f6-4...	Heritage Place	Asmar Jbeil; DA...	Alternative Refe...	Defensive/Fortification; Domestic; Industrial/Productive; Religious;...	Definite; Definit...	Irr
2	EAMENA-01091...	babb7d58-f7af-...	Heritage Place	E36N34-31_000...	Alternative Refe...	Funerary/Memorial; Religious; Unknown	Definite; Definit...	Us
3	EAMENA-01127...	e3c8bc8d-c7f6-...	Heritage Place	AA'n Akrine; E3...	Alternative Refe...	Religious	Definite	Irr
4	EAMENA-01157...	6f60f375-ca91-...	Heritage Place	Akk9805; E36N3...	Alternative Refe...	Defensive/Fortification; Domestic; Religious	Definite; High; ...	Irr
5	EAMENA-01157...	0c008cec-3187-...	Heritage Place	Ayn Labwa; Cro...	Alternative Refe...	Religious	Definite	NO
6	EAMENA-01157...	3d6a3b3d-61c7...	Heritage Place	Aaqbe; Crow...	Alternative Refe...	Religious	Definite	NO
7	EAMENA-01158...	e102d648-2234-...	Heritage Place	E35N33-42_000...	Alternative Refe...	Religious	Definite	NO
8	EAMENA-01159...	a782029f-dbde-...	Heritage Place	Aaiha; E35N33-...	Alternative Refe...	Religious	Definite	NO
9	EAMENA-01159...	eab370d8-5203...	Heritage Place	Bonatz_2002_36...	Alternative Refe...	Religious	Definite	NO
10	EAMENA-01169...	fe43f4ee-685f-4...	Heritage Place	E35N33-32_000...	Alternative Refe...	Defensive/Fortification; Religious; Trade/Commercial	Definite; Definit...	Irr
11	EAMENA-01171...	febcd384-eed9-...	Heritage Place	Al-Moez Castle;...	Alternative Refe...	Defensive/Fortification; Domestic; Entertainment/Leisure; Military;...	Definite; Definit...	Irr
12	EAMENA-01172...	bee11be4-37ea...	Heritage Place	Castle of Toron;...	Alternative Refe...	Defensive/Fortification; Domestic; Religious; Trade/Commercial	Definite; High; ...	Su
13	EAMENA-01172...	215b0307-6e92-...	Heritage Place	E35N33-12_000...	Alternative Refe...	Religious	High	Irr
14	EAMENA-01176...	fada9671-0c7c-...	Heritage Place	DaA'aat el Aati...	Alternative Refe...	Domestic; Religious	High; High	Su
15	EAMENA-01178...	ba89e0b2-0d69...	Heritage Place	E36N34-12_000...	Alternative Refe...	Religious	High	Re
16	EAMENA-01337...	2ebadad6-655e...	Heritage Place	Beit Aziz; Biziz; ...	Alternative Refe...	Religious	Definite	Re
17	EAMENA-01339...	1ae3a71c-8a1e-...	Heritage Place	Bi'qat Mizpa; D...	Alternative Refe...	Defensive/Fortification; Religious	High; High	Ur

abc Function Religious Case sensitive

- In the Field Calculator type “Religious” for “Output field name”
- Change “Output field type” to “Text (string)”.
- Type “ ‘Religious’ ” into the “Expression” box (you must include the single quotes).
- Click OK.

Field Calculator

☒ Only update 17 selected features

☒ Create a new field

☐ Create virtual field

Output field name: Religious

Output field type: Text (string)

Output field length: 10 Precision: 3

☐ Update existing field

Expression: 'Religious'

Function Editor: Search... Show Help

row\_number

- Aggregates
- Arrays
- Color
- Conditionals
- Conversions
- Date and Time
- Fields and Values
- Files and Paths
- Fuzzy Matching
- General
- Geometry

Output preview: 'Religious'

You are editing information on this layer but the layer is currently not in edit mode. If you click OK, edit mode will automatically be turned on.

OK Cancel Help

If you scroll to the last column in the Attribute Table, you will see that it is now the “Religious” column and that all the sites within it have the same label.

All\_Roman\_Sites\_Lebanon\_IV :: Features Total: 196, Filtered: 17, Selected: 17

join_DIS_1	join_CATCH	join_UPLAN	join_ENDOR	join_DIS_A	join_ORD_S	join_ORD_C	join_ORD_F	join_HYBAS	Religious
1	0.0000000000...	36.7500000000...	36.6000000000...	0	0.472	1	1	7	2120000840 Religious
2	2.0000000000...	35.3299999999...	593.2000000000...	0	8.340000000000...	3	1	6	2120746920 Religious
3	30.0000000000...	14.0100000000...	14.0000000000...	0	0.191	1	2	7	2120000860 Religious
4	50.0000000000...	9.1900000000...	9.199999999999...	0	0.125	1	2	7	2120746920 Religious
5	3.0000000000...	49.5499999999...	85.7000000000...	1	0.74	2	3	7	2120768140 Religious
6	1.0000000000...	22.5500000000...	184.8000000000...	1	1.548000000000...	2	2	6	2120768140 Religious
7	1.0000000000...	10.8900000000...	55.5000000000...	0	0.522	2	3	7	2120763000 Religious
8	30.0000000000...	32.0499999999...	32.1000000000...	1	0.234	1	3	7	2120768230 Religious
9	30.0000000000...	22.3500000000...	22.3000000000...	1	0.193	1	3	7	2120768140 Religious
10	40.0000000000...	15.7400000000...	15.4000000000...	0	0.154	1	1	7	2120000740 Religious
11	40.0000000000...	15.7400000000...	15.4000000000...	0	0.154	1	1	7	2120000740 Religious
12	1.0000000000...	65.2099999999...	65.2000000000...	0	0.53	1	1	7	2120000630 Religious
13	6.0000000000...	27.4800000000...	27.5000000000...	0	0.234	1	2	7	2120000620 Religious
14	40.0000000000...	14.9200000000...	14.9000000000...	0	0.187	1	4	7	2120754500 Religious
15	3.9999999999...	21.6900000000...	85.0000000000...	0	1.095000000000...	2	3	6	2121273270 Religious
16	5.0000000000...	32.1199999999...	32.1000000000...	0	0.434	1	1	7	2120000860 Religious
17	1.0000000000...	23.8700000000...	23.8999999999...	0	0.271	1	2	7	2120761990 Religious

abc Function Religious Case sensitive

- Click the Filter “Function” button and select “Show All Features”

All\_Roman\_Sites\_Lebanon\_IV :: Features Total: 196, Filtered: 196, Selected: 17

join_DIS_1	join_CATCH	join_UPLAN	join_ENDOR	join_DIS_A	join_ORD_S	join_ORD_C	join_ORD_F	join_HYBAS	Religious
1	99999999...	19.5100000000...	202.5000000000...	0	2.620000000000...	3	1	6	2120000850 NULL
2	99999999...	19.5100000000...	202.5000000000...	0	2.620000000000...	3	1	6	2120000850 NULL
3	00000000...	14.3800000000...	14.1999999999...	0	0.186	1	1	7	2120000840 NULL
4	00000000...	14.3800000000...	14.1999999999...	0	0.186	1	1	7	2120000840 NULL
5	99999999...	19.5100000000...	202.5000000000...	0	2.620000000000...	3	1	6	2120000850 NULL
6	99999999...	19.5100000000...	202.5000000000...	0	2.620000000000...	3	1	6	2120000850 NULL
7	99999999...	19.5100000000...	202.5000000000...	0	2.620000000000...	3	1	6	2120000850 NULL
8	99999999...	19.5100000000...	202.5000000000...	0	2.620000000000...	3	1	6	2120000850 NULL
9	00000000...	14.3800000000...	14.1999999999...	0	0.186	1	1	7	2120000840 NULL
10	99999999...	19.5100000000...	202.5000000000...	0	2.620000000000...	3	1	6	2120000850 NULL
11	00000000...	36.7500000000...	36.6000000000...	0	0.472	1	1	7	2120000840 Religious
12	99999999...	2.650000000000...	216.9000000000...	0	3.327000000000...	3	1	6	2120000930 NULL
13	00000000...	18.0200000000...	18.0000000000...	0	0.24	1	2	7	2120746920 NULL
14	00...	00...	00...	0	8.340000000000...	3	1	6	2120746920 Religious
15	99...	00...	00...	0	8.867000000000...	3	1	6	2120746920 NULL
16	00...	00...	00...	0	1.785000000000...	2	1	6	2120000910 NULL
17	00...	00...	00...	0	14.7720000000...	4	1	5	2120000950 NULL

Show All Features Show Selected Features Show Features Visible On Map Show Edited and New Features Field Filter Advanced Filter (Expression) Stored Filter Expressions Show All Features

You will see that only the fields you selected have the “Religious” label.

We now want to repeat this process for settlement sites.

- Click the Filter “Show All Features” button and select “Field Filter” > “Interpreta[tion]”.
- Type “Settlement” in the bottom box and press the Enter key.
- Select all the filtered records using the Shift key.
- Click the “Field Calculator” button.
- Create a “Settlement” text field.
- Type “ ‘Settlement’ ” into the “Expression” box and click OK.

**Field Calculator**

☒ Only update 196 selected features

☒ **Create a new field** ☐ Update existing field

☐ Create virtual field

Output field name:

Output field type:

Output field length:  Precision:

Expression:

Function Editor:

- row\_number
- Aggregates
- Arrays
- Color
- Conditionals
- Conversions
- Date and Time
- Fields and Values
- Files and Paths
- Fuzzy Matching
- General
- Geometry

Output preview: 'Settlement'

OK Cancel Help

- Click the Filter “Interpretation” button and select “Show All Features”.
- Click the “Edit” button to turn editing off.
- Click the “Deselect all” button to clear the selection.

QGIS All\_Roman\_Sites\_Lebanon\_IV :: Features Total: 196, Filtered: 196, Selected: 0

	join_CATCH	join_UPLAN	join_ENDOR	join_DIS_A	join_ORD_S	join_ORD_C	join_ORD_F	join_HYBAS	Religious	Settlement
1	510000000000...	202.5000000000...	0	2.620000000000...	3	1	6	2120000850	NULL	NULL
2	510000000000...	202.5000000000...	0	2.620000000000...	3	1	6	2120000850	NULL	NULL
3	380000000000...	14.199999999999...	0	0.186	1	1	7	2120000840	NULL	NULL
4	380000000000...	14.199999999999...	0	0.186	1	1	7	2120000840	NULL	Settlement
5	510000000000...	202.5000000000...	0	2.620000000000...	3	1	6	2120000850	NULL	NULL
6	510000000000...	202.5000000000...	0	2.620000000000...	3	1	6	2120000850	NULL	NULL
7	510000000000...	202.5000000000...	0	2.620000000000...	3	1	6	2120000850	NULL	NULL
8	510000000000...	202.5000000000...	0	2.620000000000...	3	1	6	2120000850	NULL	NULL
9	380000000000...	14.199999999999...	0	0.186	1	1	7	2120000840	NULL	NULL
10	510000000000...	202.5000000000...	0	2.620000000000...	3	1	6	2120000850	NULL	NULL
11	750000000000...	36.600000000000...	0	0.472	1	1	7	2120000840	Religious	NULL
12	650000000000...	216.9000000000...	0	3.327000000000...	3	1	6	2120000930	NULL	Settlement

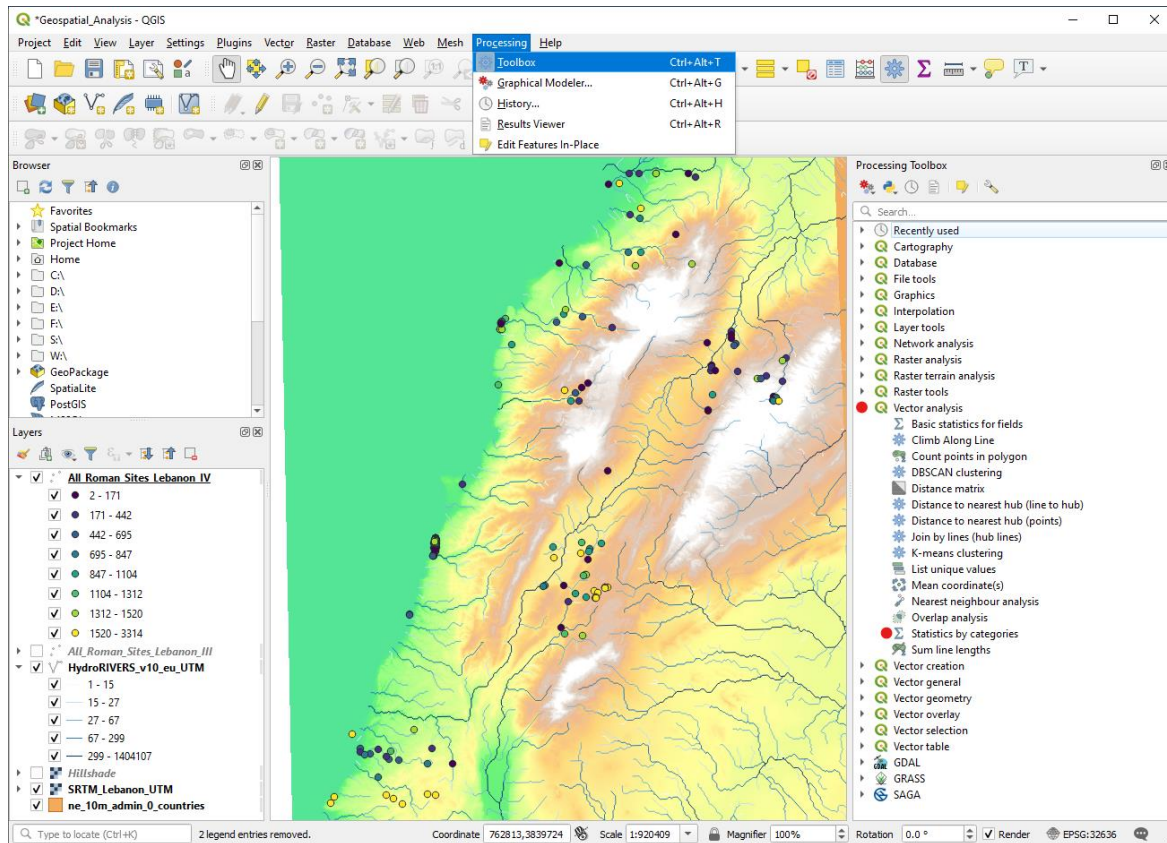
Show All Features

If you scroll to the right you will see that you now have two new fields with “Religious” and “Settlement” sites marked separately.

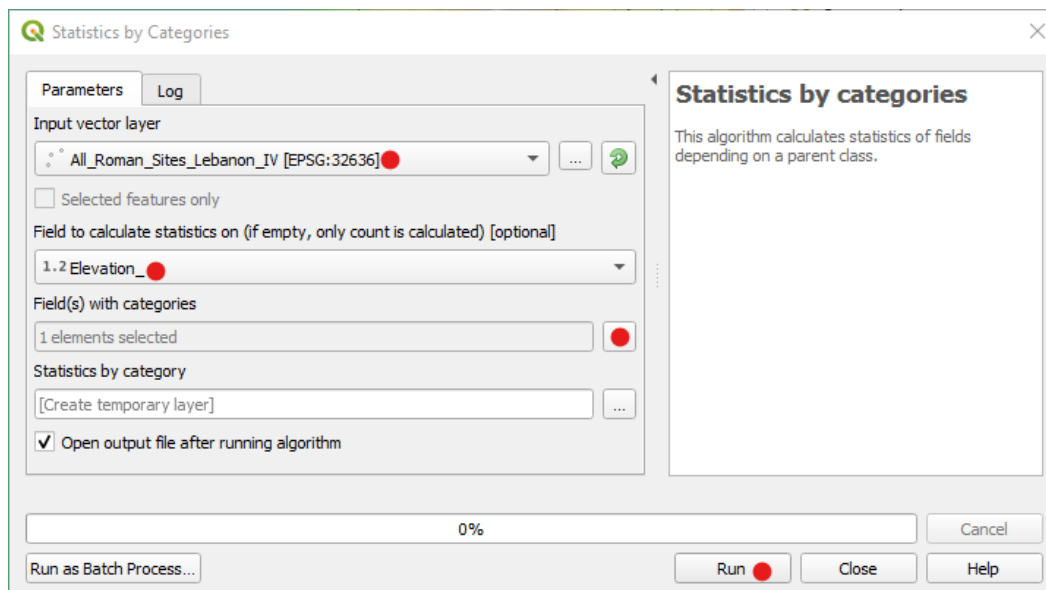


We are now going to calculate some statistics based on these two fields to try and answer our questions.

- On the Menu select “Processing” > “Toolbox”.
- Expand “Vector analysis” and double-click on “Statistics by categories”.



- Select your sites shapefile for “Input vector layer”.
- For “Field to calculate statistics on” select “Elevation”.
- For “Fields with categories” select “Religious”.
- Click Run.



A new table will be added to the Layers Panel.

- Right-click this table and select “Open Attribute Table”.

	Religious	count	unique	min	max	range	sum	mean	median	stddev
1	Religious	17	17	19	1370	1351	12041	708.2941176470...	718	454.5632376515...
2	NULL	179	114	2	2241	2239	91175	509.3575418994...	32	659.1943411668...

You will see that statistics have been calculated on the elevation of religious sites and non-religious sites.

We are most interested in the mean and median statistics.

- The ‘mean’ value is the average elevation of the sites in that group.
- The ‘median’ value is the middle value in the list of the elevations in that group.

In this case, both the mean and the median elevations are considerably higher for religious sites than the non-religious (NULL) sites. This helps us to answer the question of whether or not Roman religious sites are higher than other Roman sites: Roman religious sites are, on average, located at higher elevations than other Roman sites.

Now we are going to use the same method to answer our second question.

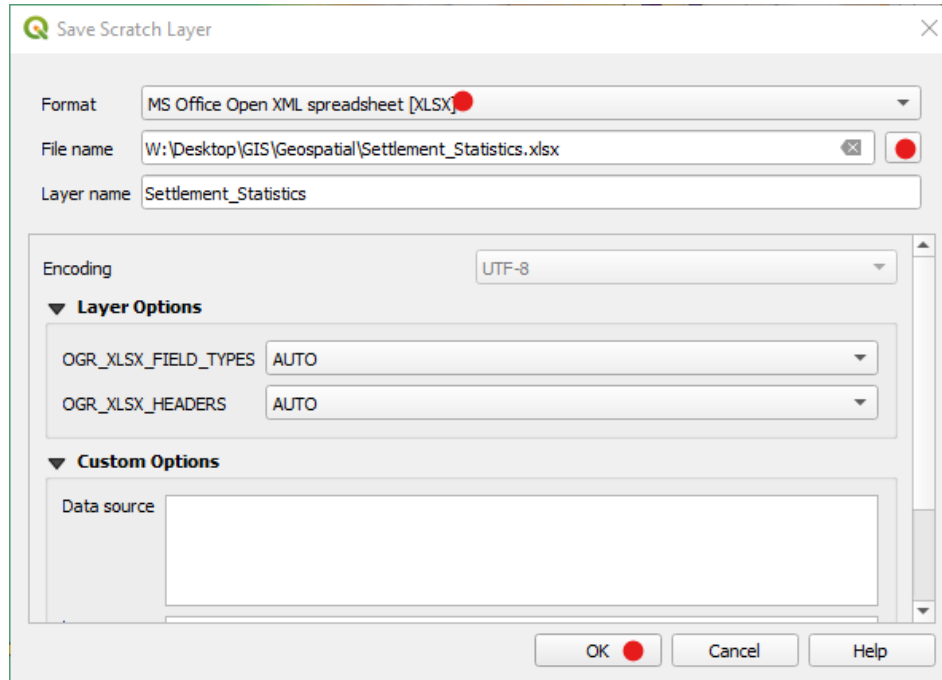
- Double-click again on “Statistics by categories” in the Processing Toolbox.
- Select your sites shapefile for “Input vector layer”.
- For “Field to calculate statistics on” select “Distance”.
- For “Fields with categories” select “Settlement”.
- Click Run.
- Right-click the new table and select “Open Attribute Table”.

	Settlement	count	unique	min	max	range	sum	mean	median	stddev
1	Settlement	67	67	2.419844047987...	2717.714564904...	2715.294720856...	52988.94606780...	790.8797920567...	640.6479862135...	600.3689966436...
2	NULL	129	129	5.63082972783527	3314.329634986...	3308.69880525843	134604.2765018...	1043.444003890...	1013.281652896...	726.8913982296...

Notice that both the mean and median values for Settlement sites are considerably higher than for non-settlement (NULL) sites. Therefore, we can conclude that our Roman settlement sites are closer to river channels on average than non-settlement sites!

If we want to keep our results we need to save them.

- Right-click the newest table and select “Make permanent”.
- For file-type select “MS Office Open XML Spreadsheet”.
- Click the Browse button [...] and save it in the Geospatial folder and click OK.



- Repeat for the other table

You can now also open these files in Excel or other spreadsheet software if you want.

**PRACTICE:** use this method to calculate the average upstream catchment area for a site category of your choice.

**ACTIVITY:** set yourself some questions relating to elevation and/or hydrology from your data and answer them using these simple geospatial analyses.