

# Tutorial for working with QGIS software

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## Foreword



QGIS (<http://www.qgis.org/>) is an Open Source Geographic Information System licensed under the GNU General Public License. The project was born in May 2002 and was then established as a project on SourceForge. QGIS is now an official project of the Open Source Geospatial Foundation (OSGeo: <http://www.osgeo.org>).



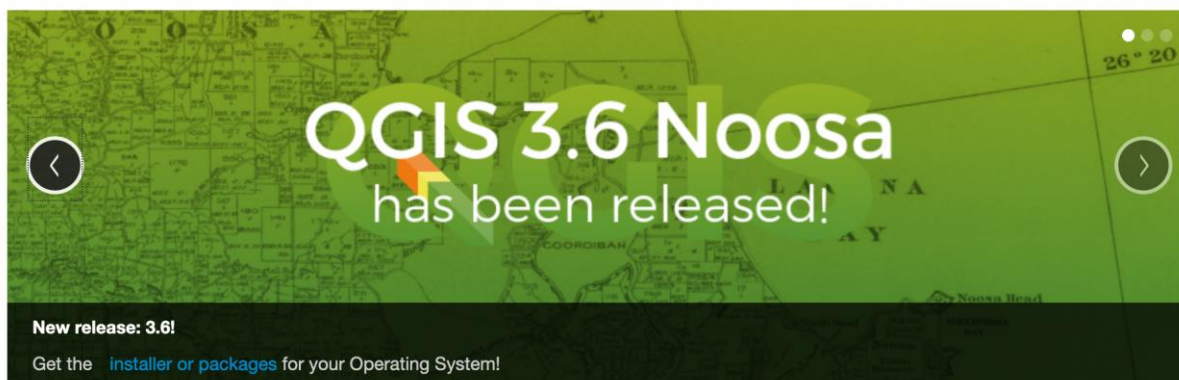
**QGIS allows users to view, manage, edit and analyze spatial information, in addition to composing and exporting maps.** Among GIS software, QGIS is **simple to use and intuitive**. When it was created, QGIS only offered the main functionalities, but it benefits from a very active community and is evolving rapidly. Today, it has become an essential GIS software, **among the most powerful and complete**.

QGIS has the advantage of running under different systems: Linux, Unix, Mac OSX, Windows and Android. It supports many vector, raster and database formats and functionalities. It has an ever-increasing list of features through a powerful plugins system. QGIS integrates with other open-source GIS packages, including PostGIS, GRASS, MapServer, GeoNode.

QGIS is maintained by volunteer developers who release updated versions every four months and many plugins. Older versions are still available for download. An LTR (Long Term Release) version is released approximately every 2 years. The latest release is QGIS 3.6 (called Noosa)

## QGIS

### A Free and Open Source Geographic Information System



## Useful links

### QGIS tutorials (QGIS 3.6)

QGIS official Training Manual: [http://docs.qgis.org/latest/en/docs/training\\_manual/index.html](http://docs.qgis.org/latest/en/docs/training_manual/index.html)

QGIS Tutorials and tips, by Ujaval Gandhi.: <https://www.qgistutorials.com/en/>

Introduction to GIS Fundamentals, by Datapolitan: [http://training.datapolitan.com/qgis-training/Introduction\\_to\\_GIS\\_Fundamentals](http://training.datapolitan.com/qgis-training/Introduction_to_GIS_Fundamentals)

### QGIS tutorials in French (QGIS 2.18):

Tutorial created by “pôle Analyse et Représentation des données de l'UMR PASSAGES”.

<http://ouvrir.passages.cnrs.fr/tutoqgis/>

### Spatial data

Several websites providing free spatial data are listed here:

[https://www.netvibes.com/geohealth?#Online\\_databases](https://www.netvibes.com/geohealth?#Online_databases)

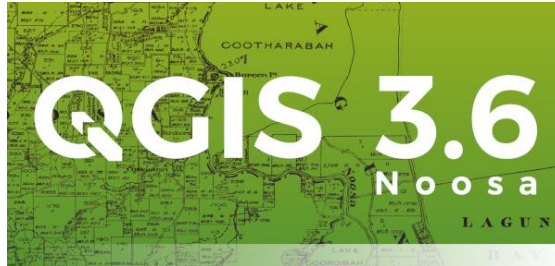
For more information on GeoHealth researches, follow:

<https://www.facebook.com/geohealthresearch/>

# 1. Installing and starting QGIS

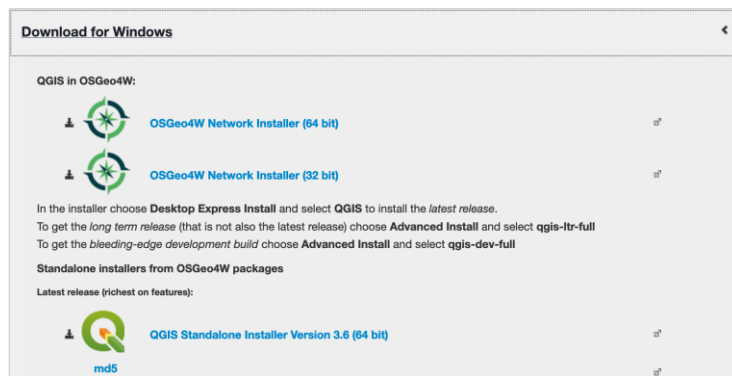
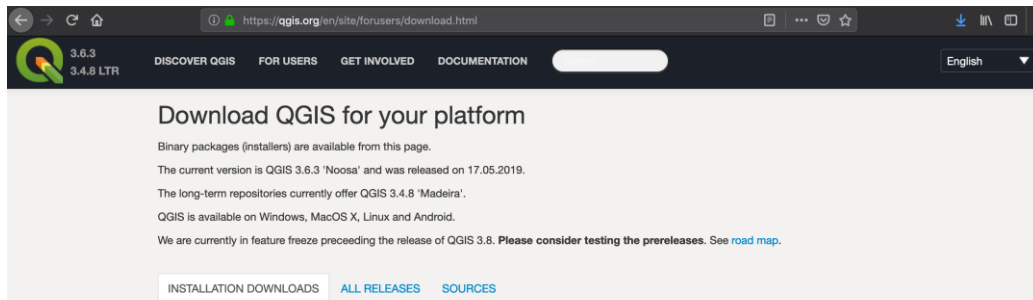
## 1.1. Downloading and installing QGIS

- The latest version is QGIS 3.6, called Noosa and published on February 2019
- The latest Long Term Release (LTR) is QGIS 3.4, called Madeira and published on October 2018.

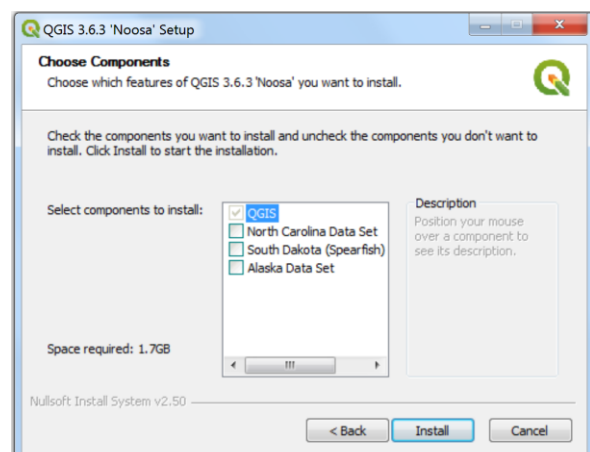


- Download from QGIS website:


<https://qgis.org/en/site/forusers/download.html>



- The installation does not raise any particular difficulties

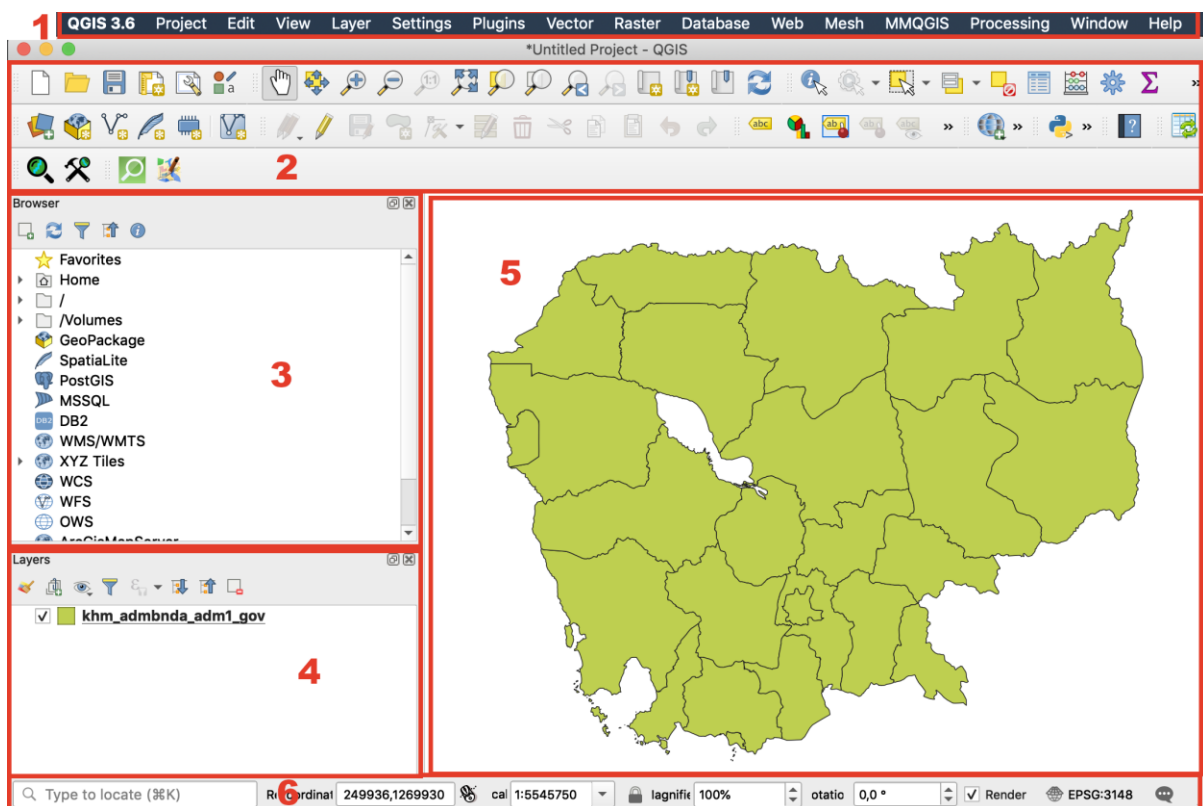


## 1.2. Starting QGIS

- Use the QGIS shortcut on desktop :  QGIS Desktop 3.6.3
- Or go to: Startup menu / All Programs / QGIS 3.6 / QGIS Desktop 3.6.3

The QGIS graphical interface is divided into 6 zones:

1. Menu Bar
2. Toolbars
3. File browser
4. Layers, Legends
5. Map canvas
6. Locator bar

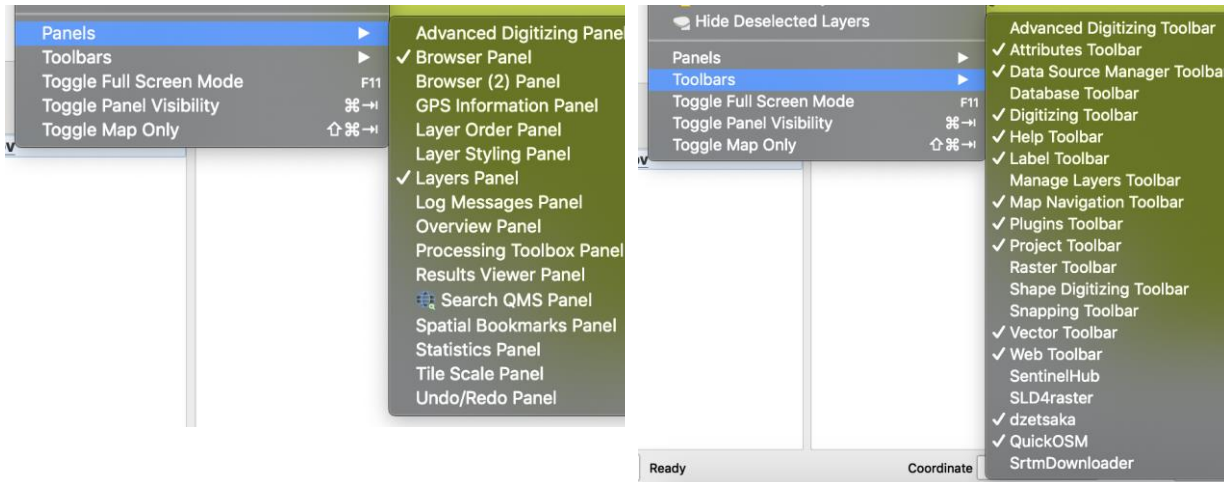


*Note : The graphical user interface may appear differently depending on your operating system and configuration of toolbars.*

The available toolbars depend on the installed plugins.

Panels and toolbars can be displayed or hidden by:

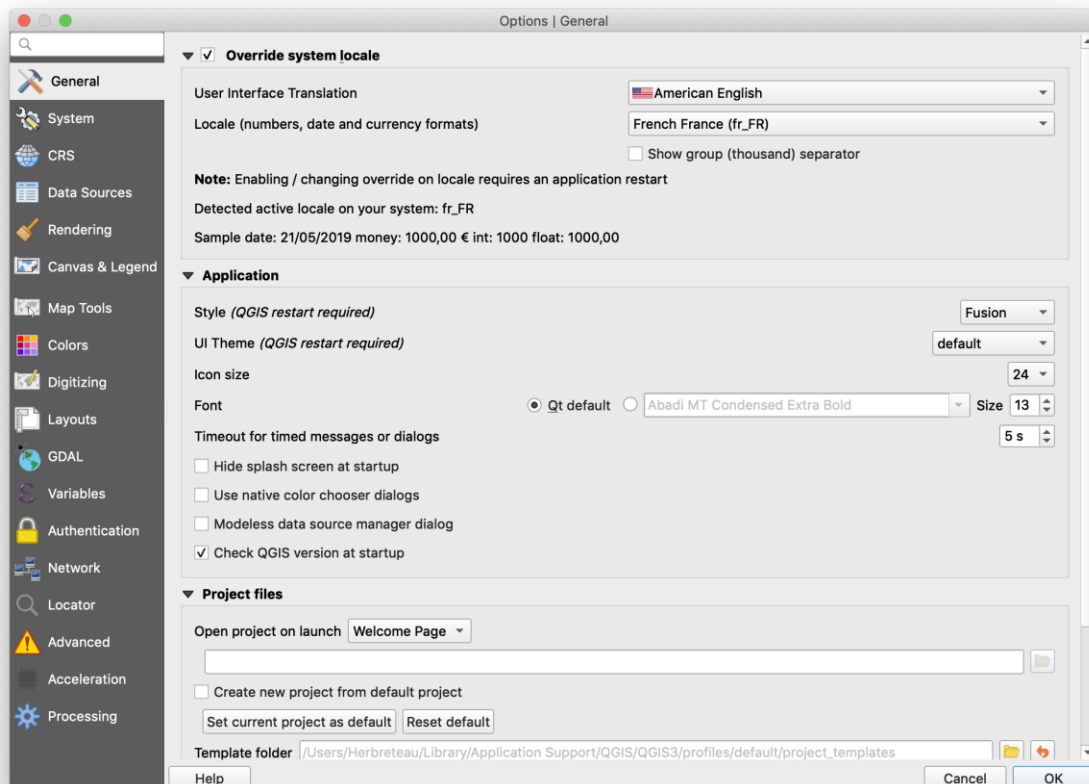
- right-clicking in the grey area of the toolbars to open the panel selection (top list) and toolbar selection (bottom list).
- Going to the View Menu / Panels or View / Toolbars



### 1.3. Specifying QGIS options

QGIS is developed in English but the GUI can be used in different languages according to the available translations. It is easy to switch from one language to another one:

- Go to the Preferences / General tab
- Select Override system locale if necessary and chose the translation



- Verify also the units and date formats in the Locale list.



## 2. Creating a simple map and discovering the different toolbars

### 2.1. Downloading dataset

#### Cambodia administrative boundaries, divided in 4 levels:

- level 0: country,
- level 1: province / khaet and capital / reach thani,
- level 2: municipality, district,
- level 3: commune / khum, quarter / sangkat

These contours maps (shapefiles) are made available from the Humanitarian Data Exchange (HDX), provided by OCHA (United Nations Offices for the Coordination of Humanitarian Affairs: <https://www.unocha.org/>). These maps were originally produced by the Department of Geography of the Ministry of Land Management, Urbanization and Construction in 2008 and unofficially updated in 2014 according to sub-decrees on administrative modifications. They were provided by WFP - VAM unit Cambodia.

You can download these administrative boundaries, as zip folders, here:

<https://data.humdata.org/dataset/cambodia-admin-level-0-international-boundaries>

- [khm\\_admbnda\\_adm0\\_gov\\_20181004.zip](#) (127.0K)
- [khm\\_admbnda\\_adm1\\_gov\\_20181004.zip](#) (292.6K)
- [khm\\_admbnda\\_adm2\\_gov\\_20181004.zip](#) (589.2K)
- [khm\\_admbnda\\_adm3\\_gov\\_20181004.zip](#) (1.2M)

#### Population data:

Population data is available at these different levels from the Humanitarian Data Exchange (HDX) repository. It comes from the Commune database (CDB), provided by the Cambodia Ministry of Planning.

<https://data.humdata.org/dataset/cambodia-population-statistics>

#### Health Facility data:

The Humanitarian Data Exchange (HDX) repository provides a dataset on the location of health facilities (Referral Hospitals, Health Centers, Health Posts). These maps were originally produced by the Cambodia Ministry of Health (MoH).

<https://data.humdata.org/dataset/cambodia-health>

#### Transportation data:

The roads network is available from Humanitarian Data Exchange (HDX) repository. These maps were originally produced by the Cambodia Department of Geography of the Ministry of Land Management, Urbanization and Construction. They include: National road primary and secondary, Provincial road primary, Provincial and rural roads, Foot path, Cart track, Bridge line.

<https://data.humdata.org/dataset/cambodia-roads>

#### Hydrology data:

The hydrological network is available from Humanitarian Data Exchange (HDX) repository. These maps were originally produced by the Cambodia Department of Geography of the Ministry of Land Management, Urbanization and Construction. They include: rivers (“Non-Perennial/Intermittent/Fluctuating” and “Perennial/Permanent”), lakes

<https://data.humdata.org/dataset/cambodia-water-courses-0>





### Digital Elevation Model (DEM)

The SRTM (Shuttle Radar Topography Mission) is a free DEM provided by NASA and NGA (formerly NIMA). Space Shuttle Endeavour (STS-99) collected these altimetry data during an 11-day mission in February 2000 at an altitude of 233 km using radar interferometry. The SRTM covers nearly 80% of the land area from 56° South latitude to 60° North latitude. Spatial resolution is approximately 30 meters on the line of the Equator.

The SRTM data can be downloaded here: <http://srtm.csi.cgiar.org>

## 2.2. Creating a project

QGIS starts with an untitled project but displays in the canvas the list of recent projects. By double-clicking on one of these recent projects, QGIS will quickly open it.

- You can start by saving your future project (file extension .qgz) :

In Menu **Project -> Save as...**

or by using the **File Toolbar**



*Note: Remember to frequently save your project!*

## 2.3. Adding a vector layer

*Note: Vector layers can be points, polylines or polygons.*

- Add the four levels of Cambodian administrative layers (provinces, districts, communes) to the project:
  - khm\_admbnda\_adm0\_gov\_20181004.shp (country)
  - khm\_admbnda\_adm1\_gov\_20181004.shp (provinces)
  - khm\_admbnda\_adm2\_gov\_20181004.shp (districts)
  - khm\_admbnda\_adm3\_gov\_20181004.shp (communes)

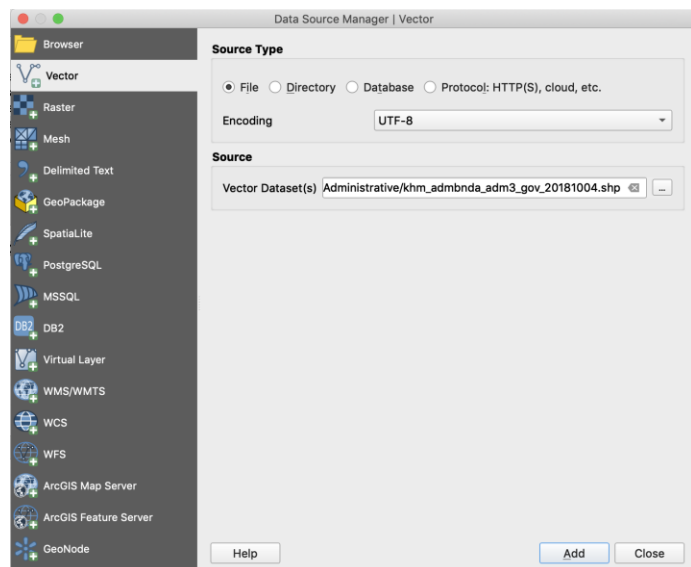
There are several ways to add data to the project

- By using the Data Source Manager

- Open the **Data Source Manager** by clicking on its icon in the Data Source Manager Toolbar



- Select the type of data to open : Vector / Raster / Delimited Text (csv) / etc.
- Browse to your file
- Click on Add button



- By using the **Browser panel**
  - Find the .shp files in your folders
  - Double-click the .shp files directly or drag and drop it to the map canvas
- By directly **dragging and dropping** the .shp files from your browser to QGIS

*Note: You can select and open several files together with Ctrl or Shift keys.*

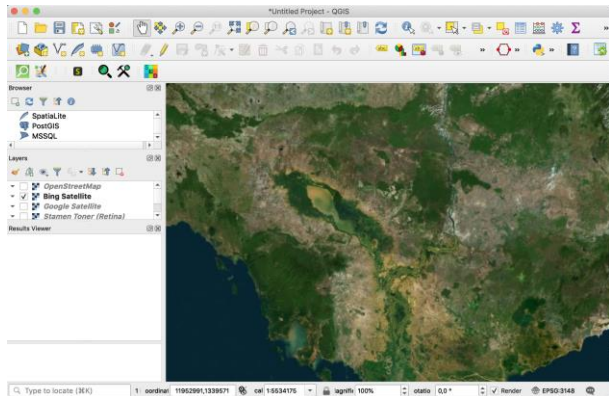
*Note: You can drag and drop layers in the table of contents to modify the order of appearance of the layers*



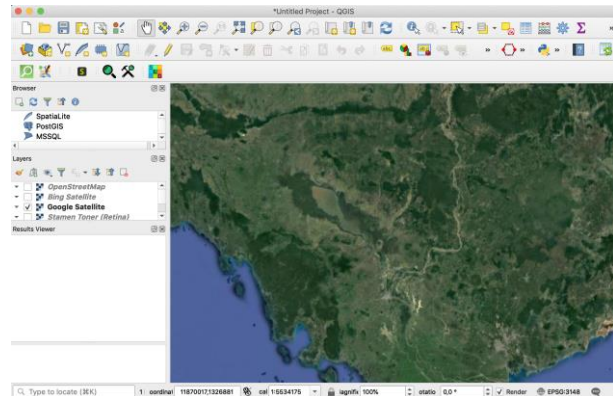
## 2.4. Adding a basemap

QGIS 3 makes it very easy to add background maps (OpenStreetMap, Bing, MapBox, Google, etc.). Of course, this requires Internet connection.

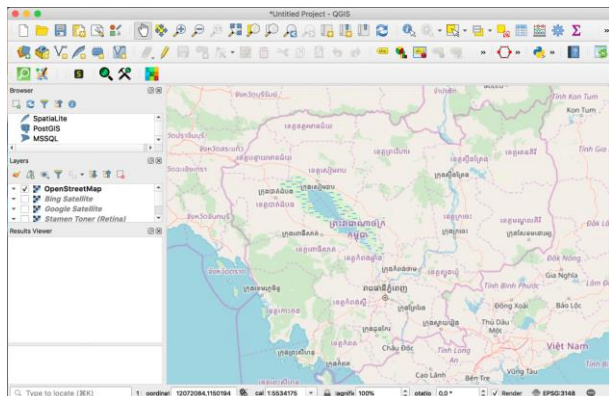
Examples of basemap from different providers:



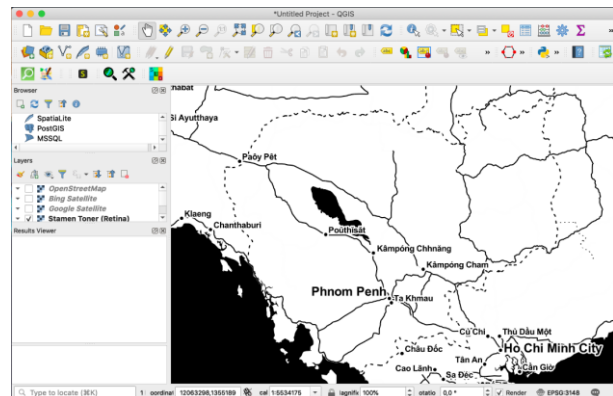
Microsoft Bing Satellite basemap



Google Satellite basemap



OpenStreetMap basemap

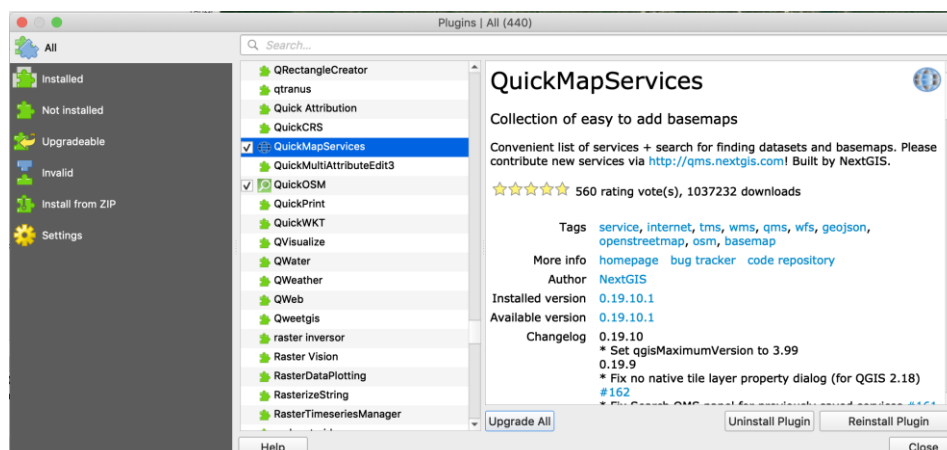


Stamen Toner basemap

There are several ways to add basemaps to QGIS:

1. **By using the Browser panel:**
  - In the Browser panel, go to XYZ Tiles and double click on OpenStreetMap
2. **By using a dedicated plugin:**

You can also get a large list of basemaps using the **QuickMapServices** plugin:



- Install QuickMapServices plugin by opening the Plugin Manager
- Menu Plugins / Install and Manage Plugins...
- Search for QuickMapServices (you can type “Quick” in the Search window)

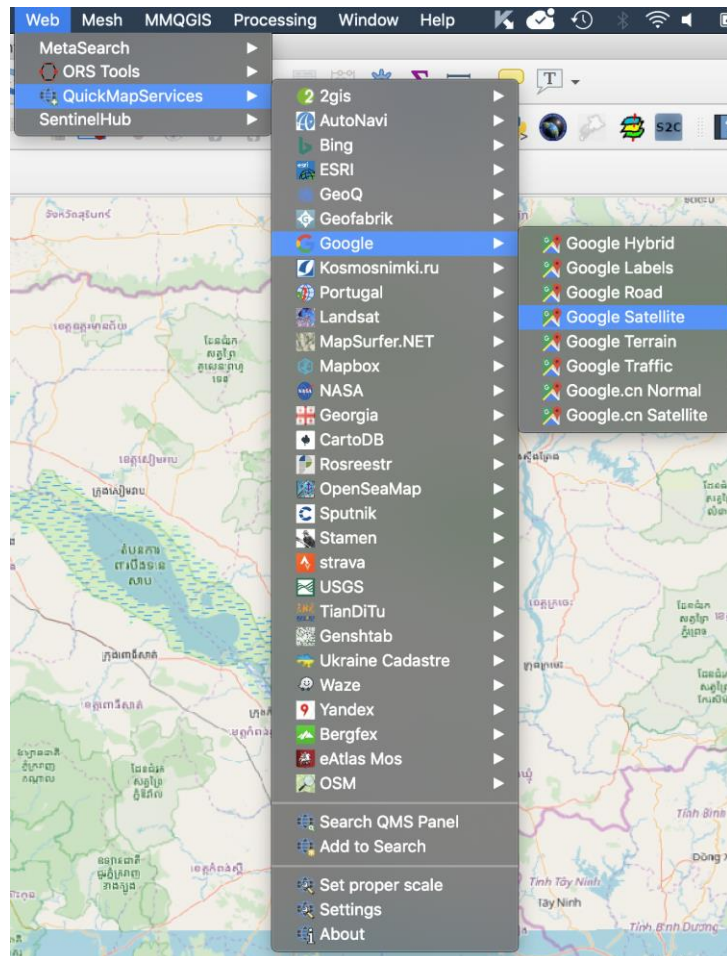
-> this plugin will be installed in the Web Menu

- Go to Menu Web / QuickMapServices
- Select the basemap you would like to display

QuickMap Services Plugin offers also precise settings for the visibility of the maps in the plugin, for getting more maps or for the download timeout.

- In the QuickMapServices Menu, go to Settings
- Go to the More Services tab
- Click on “Get contributed pack” to obtain more maps

*Note: do not open too many basemaps since it will require internet*



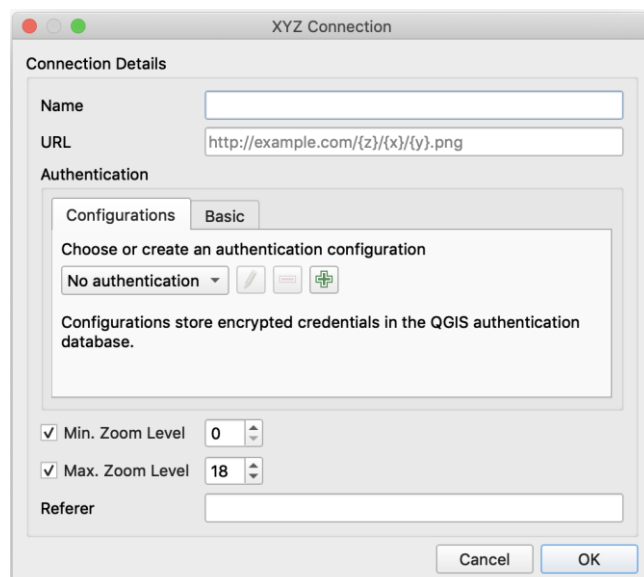
Alternatively, you can use the OpenLayers Plugin that will be also installed in the Web Menu but it offers less possibilities.

It is possible to add more basemaps in the XYZ Tiles Browser by connecting to other tile services

See:

<https://opengislab.com/blog/2018/4/15/add-basemaps-in-qgis-30>

- Right-click on XYZ Tiles in the Browser Panel
- Select New Connection...
- Enter the name and URL of basemap  
Example for Google Satellite:  
`https://mt1.google.com/vt/lyrs=s&x=%7Bx%7D&y=%7By%7D&z=%7Bz%7D`



There is also the possibility to use a Python script to directly add several basemaps to the Browser:

- Copy the script here:  
[https://raw.githubusercontent.com/klakar/QGIS\\_resources/master/collections/Geosupportsystem/python/qgis\\_basemaps.py](https://raw.githubusercontent.com/klakar/QGIS_resources/master/collections/Geosupportsystem/python/qgis_basemaps.py)
- Open the Python Console in the Plugins Menu / Python Console
- Paste the script and Run Python
- It will automatically update the liste of XYZ tiles (Thanks to the contributors of this nice Python script!).

```

Python Console
1 Python Console
2 Use iface to access QGIS API interface or Type help(iface) for more info
3 Security warning: typing commands from an untrusted source can lead to data loss and/or Leak
4 >>> """
5 ... This script should be run from the Python consol inside QGIS.
6 ... It adds online sources to the QGIS Browser.
7 ... Each source should contain a list with the following items (string type):
8 ... [sourcetype, title, authconfig, password, referer, url, username, zmax, zmin]
9 ... You can add or remove sources from the sources section of the code.
10 ... Script by Klas Karlsson
11 ... Sources from https://qms.nextgis.com/
12 ... Licence GPL-3
13 ... Regarding the terms of use for these background maps YOU will need to verify that you
14 ... follow the individual EULA that comes with the different services,
>>> iface.reloadConnections()

```

Coordinate: 12648902,1009557 Scale: 1:11083960 Magnifier: 100% Rotation: 0,0 ° Render EPSG:3148

## 2.5. Moving around the map

### Map Navigation toolbar

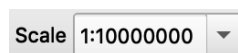


Test the different tools:

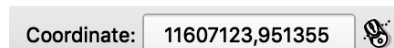
- Pan map,
- Pan map to selection,
- Zooming: Zoom In, Zoom Out, Zoom to Native Resolution, Zoom Full, Zoom to Selection, Zoom to Layer, Zoom Last, Zoom Next,
- Refresh

### Control the scale and the geographic coordinates of the map:

A **specific scale** can be given on the bottom right side of the window.



Also you can visualize **the coordinates** of the location of the mouse over the main window.



## 2.6. Selecting and getting information on attributes

### Attribute toolbar



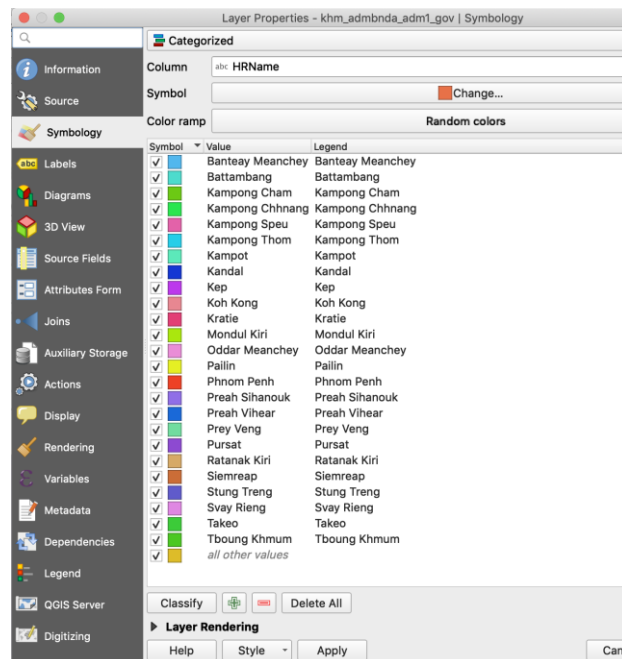
Test the different tools:

- Identify features: First select a layer in the Layer Panel and then click on the object to display its information.
- Select Features: First select a layer in the Layer Panel, then choose between:
  - o Select Feature(s),
  - o Select Features by Polygon / by Freehand / by Radius
  - o Select Features by Value
  - o Deselect Features from all layers.
- Open Attribute Table: First select a layer in the Layer Panel and then click on this icon to display its table.
- Open Field Calculator
- Open Processing Toolbox
- Show Statistical summary
- Measure Line / Area / Angle
- Show Map Tips
- New Bookmark
- Show Bookmark
- Annotation: Text / Form / HTML / SVG / Move.

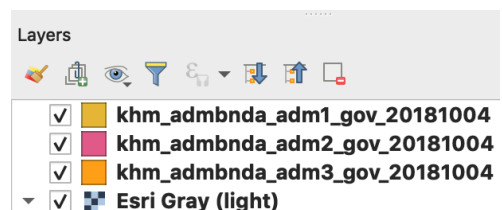
Statistic	Value
Count	1633
Sum	3.03544e+06
Mean	1858.81
Median	1664
St dev (pop)	1131.15
St dev (sample)	1131.5
Minimum	85
Maximum	12851
Range	12766
Minority	85
Majority	1974
Variety	1290
Q1	1139
Q3	2359
IQR	1220
Missing (null) values	0

## 2.7. Adjusting the symbology

- Choose **khm\_admbnda\_adm1\_gov\_20181004.shp**
- Double click on the name of the layer to open the **Layer properties** window
- Choose the **Symbology** tab
- Here you will be able to select Single symbol / Categorized / Graduated / Rule-based / Point displacement
- Choose Categorized, choose the HRName column and click on Classify
- See the different options, with colors, and layer rendering



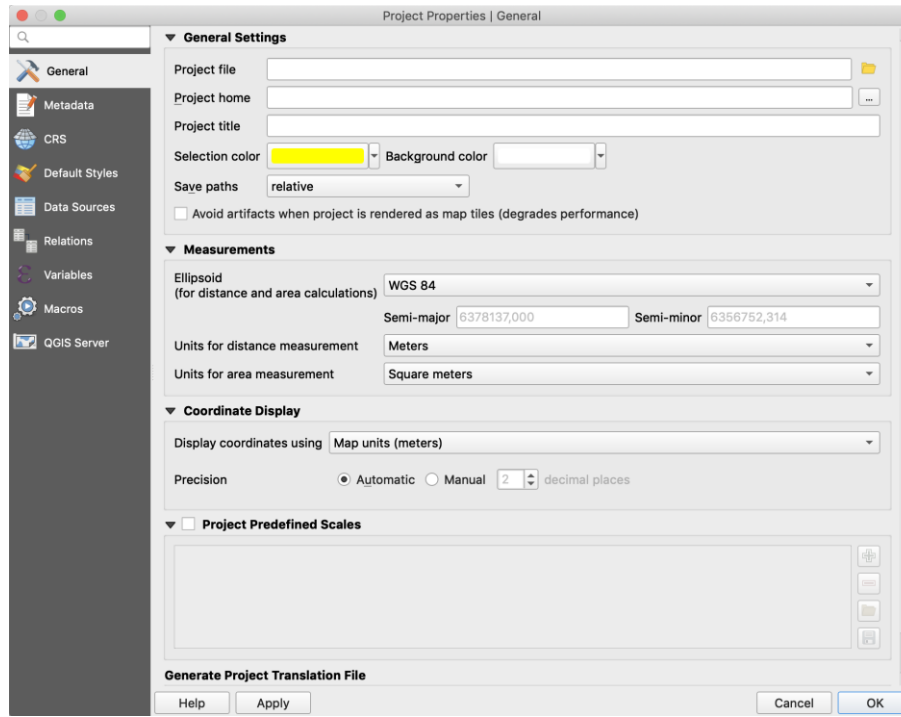
Alternatively, you can open the Layer Styling Panel with the shortcut in the top of the Layers Panel.



## 2.8. Choosing layer units

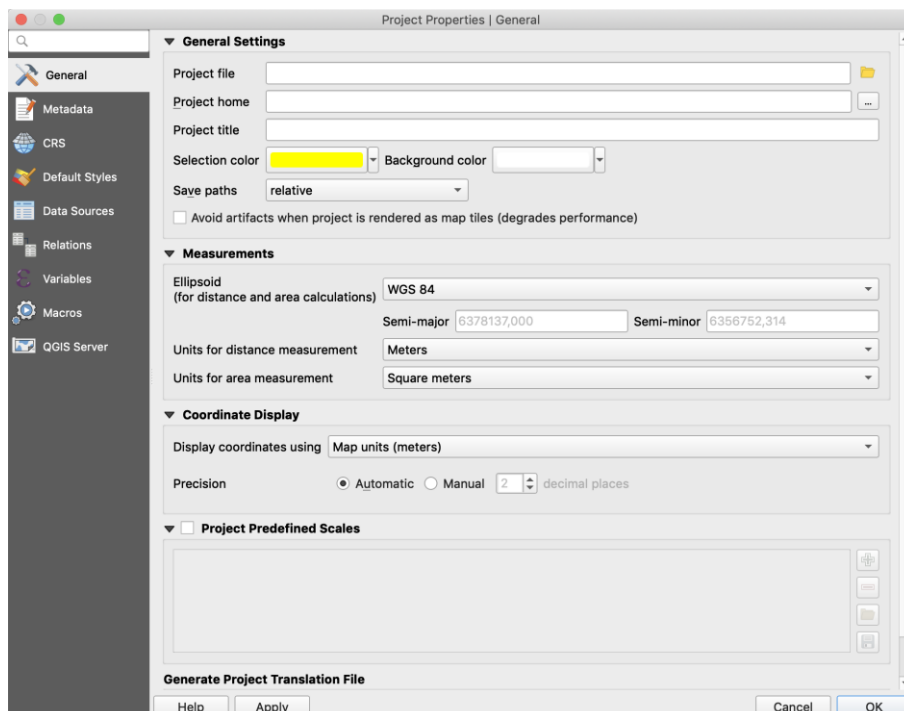
You may like to display your map either in “Degrees, Minutes, Seconds”, in “Decimal degrees” or in Meters.

- Go to Project / Properties / Tab General



## 2.9. Using projections

QGIS allows to define a Coordinate Reference System (CRS) by default or for the whole project, for layers without predefined CRS. It also allows to define customized CRS and allows the projection of vector layers on the fly.



*Notes: Layers should be in the same CRS to allow geoprocessing. Indeed, we will have to check and pay attention to the CRS of each layer when using them for spatial analyses. However QGIS can display layers with different CRS on the same extent.*


*Layers should use a projection in meters, when calculating distances or buffers.*

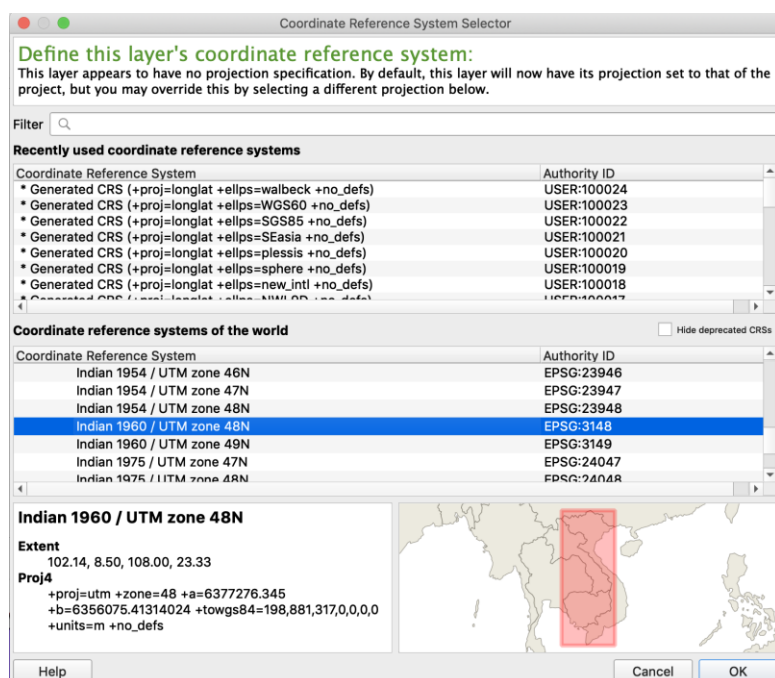
QGIS manages approximately 2,700 CRS.

For this training using data from Cambodia, we will use the following projections:

- Geographic CRS (in decimal degrees): WGS 84 (EPSG:4326)  
-> This CRS has a worldwide coverage and is used for Google and OpenStreetMap data.
- Global projected CRS (in meters): WGS 84 / UTM zone 48N (EPSG:32648)
- Local projected CRS (in meters): Indian 60 / UTM zone 48N (EPSG:3148)

### Specify the CRS of a layer:

- Double click on the name of the layer to open the **Layer properties** window
- Choose the Source tab
- Click on the Select CRS button 
- Choose the desired projection from the top list if it appears among those recently used, otherwise from the bottom list.
- Use the filter if the desired projection does not appear in the top list.
- You can save the layer with a new projection: this is the way to reproject a layer.

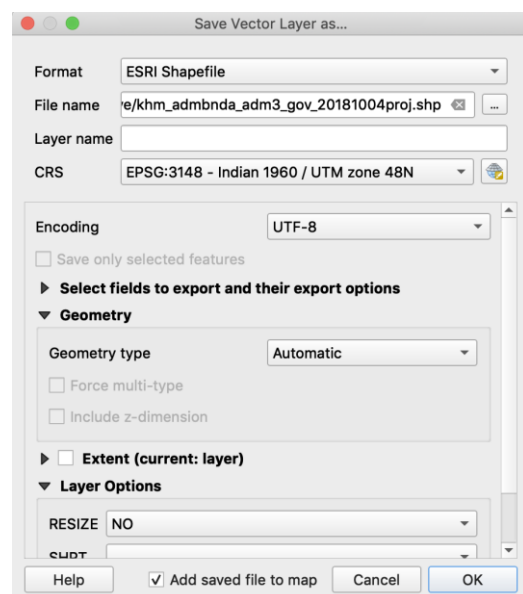


### Exercise:

- Check the CRS of your administrative files (WGS 84).
- Reproject them into Local projected CRS (Indian 60 / UTM zone 48N):
  - Right-click on the name of the layer
  - Export / Save Features As...
  - Browse to your folder and give a new name indicated they are reprojected.
  - Choose the new CRS
  - OK

### Specify the SCR of a project:

- Go to Project / Properties
- Select the Coordinate Reference System (CRS) tab
- Choose the desired CRS





### 3. Using vector data

#### 3.1. Downloading OpenStreetMap data

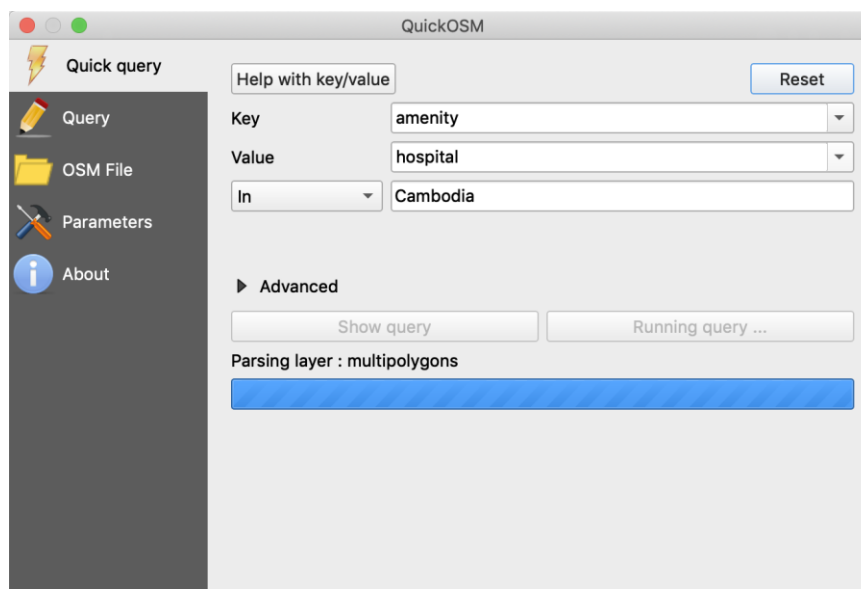
OpenStreetMap (OSM: [www.openstreetmap.org](http://www.openstreetmap.org)) is an open-access geographic database of the World. You are free to use it for any purpose as long as you credit OpenStreetMap and its contributors.

The QuickOSM plugin, developed by Etienne Trimaille at 3Liz, is the easiest way to access OSM data, through the Overpass API. Users can directly request OSM features over a given extent, by defining the keys, values and boundaries in the Quick Query tab. Users can choose to act directly on the script to best configure their request after clicking on the “Show query” button.

- Install QuickOSM from the plugins manager

#### Exercise: Download the hospitals of Cambodia

- Go to Vector / QuickOSM / QuickOSM
- In the Quick query, choose:
  - Key = amenity
  - Value = hospital
  - In = Cambodia
  - Run query
  - Data will be downloaded as polygon and points shapefiles
- In the “Advanced” list, you can choose the type of data to download (Node / Way / Relation / etc.) or increase the timeout if necessary
- Export the downloaded data as shapefile for further uses




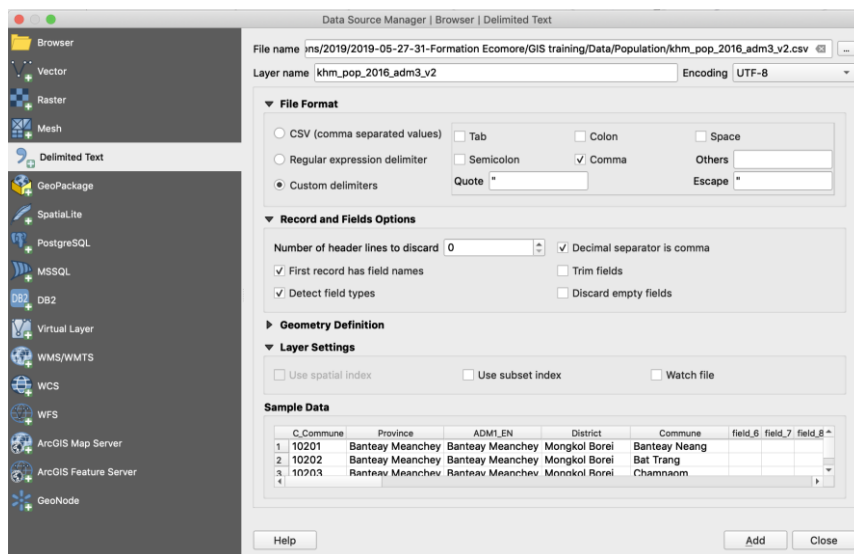
*Note:* Clicking on the “Help with key/value” will directly open the Map Features page of the OSM wiki: <https://wiki.openstreetmap.org/wiki/Mapfeatures>


For administrative boundaries, check here the administrative levels by country: [https://wiki.openstreetmap.org/wiki/Tag:boundary%3Dadministrative#10\\_admin\\_level\\_values\\_for\\_specific\\_countries](https://wiki.openstreetmap.org/wiki/Tag:boundary%3Dadministrative#10_admin_level_values_for_specific_countries)

### 3.2. Joining a data table to a map

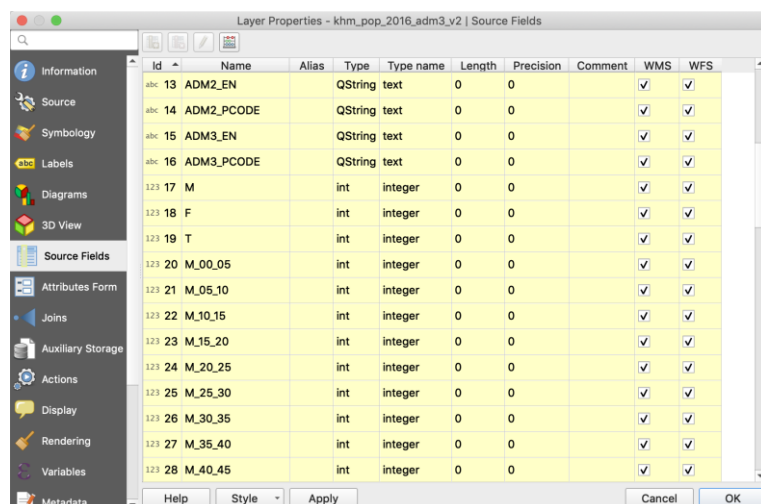
In this exercise, we will join the population data (khm\_pop\_2016\_adm3\_v2.csv) to the layer of communes khm\_admbnda\_adm3\_gov\_20181004.shp based on a common field.


1. Add the layer khm\_admbnda\_adm3\_gov\_20181004.shp to the map
2. Add the table khm\_pop\_2016\_adm3\_v2.csv the project. It cannot be directly added by double-click because settings should be carefully checked to ensure a good data format:
  - a. Open the Data Source Manager , choose the “Delimited Text” tab and browse to your csv file
  - b. Precise the file format (here, we use custom delimiters and check “Comma”). Also this file has no geometry (Check “No geometry”). Press “Add”.



When opening this file with the Open Attribute Table button  (or by right-clicking on its name), you can verify that the data attributes (M, F, T) are in a numeric format (right alignment).

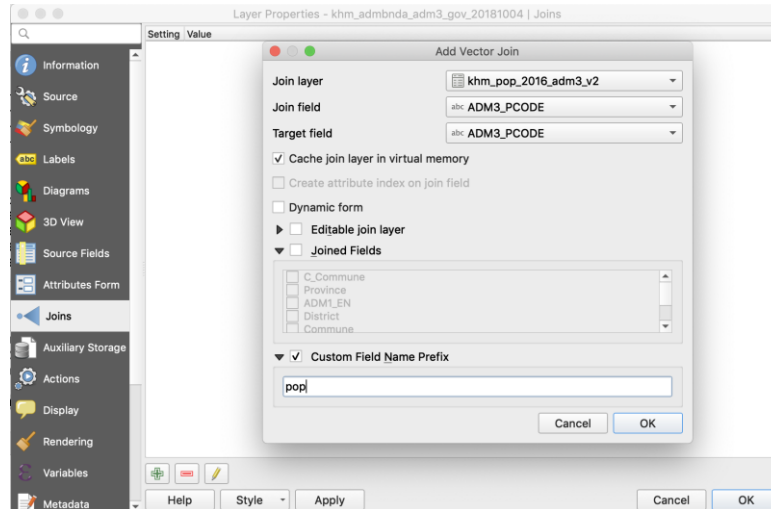
You can also verify the type of each attribute by opening the Layer Properties window (double-click on the name of the table) and opening the Source Fields tab.



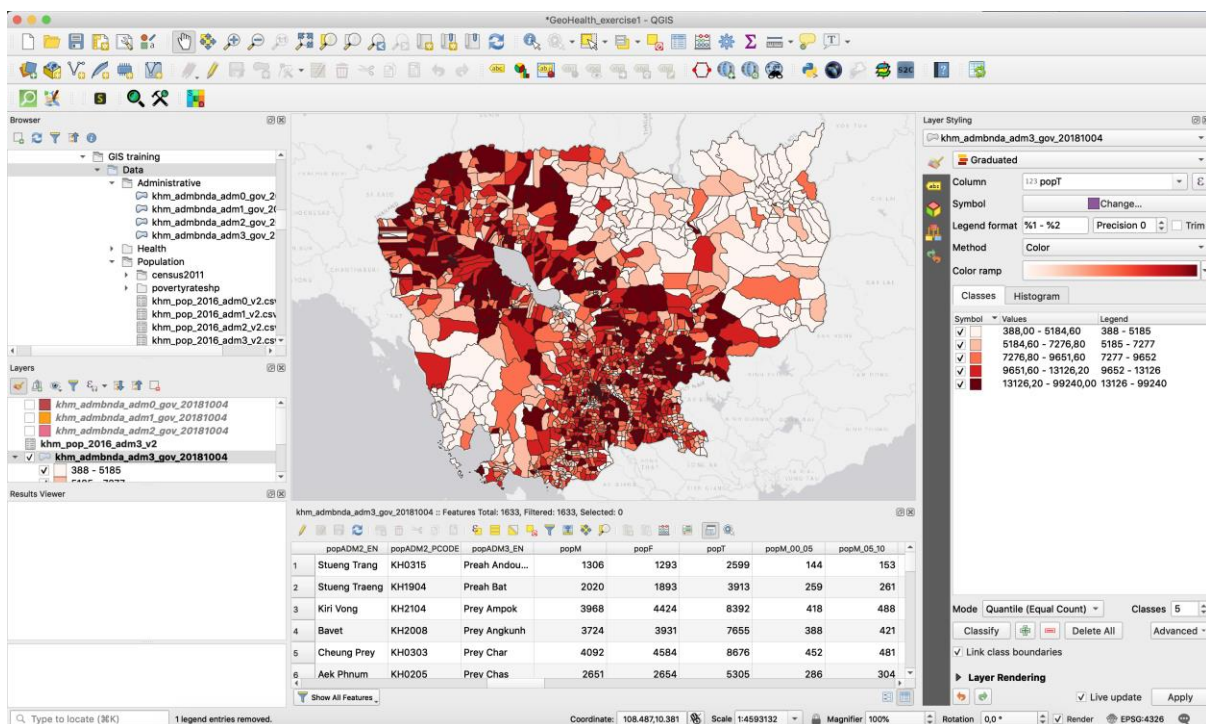
3. Open the Layer Properties window (double-click on the name of the table) of the shapefile in which you want to join the table
4. Open the Joins tab and click on the “Add New Join” button (green + button)  to add the table
5. Select:
  - a. Join layer = khm\_pop\_2016\_adm3\_v2.csv



- b. Join field = ADM3\_PCODE
- c. Target field = ADM3\_PCODE
- d. Check the “Custom Field Name Prefix” and choose a short prefix such as “pop”, otherwise the name of the joined attributes will be too long
- e. OK



6. Check that the join has enriched the attribute table of the communes layer.
7. Save this new layer under a new name to permanently record the information in the attribute table
8. Choose a symbology to display population data:
  - a. Open the Layer Styling panel
  - b. Choose “Graduated” for a continuous variable, and select the column to display
  - c. Choose a “Color ramp”, a “Mode” (Equal Interval, Quantile, Natural Breaks, Standard Deviation, Pretty breaks) and click on “Classify”, then “Apply”



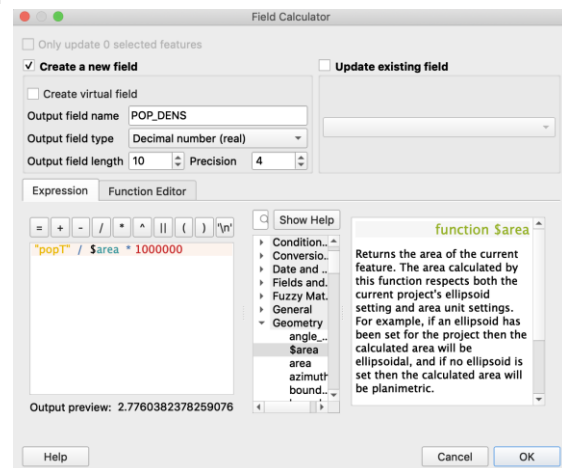
### 3.3. Creating new attributes in the attribute table

In this exercise, we will calculate the population densities from the Commune layer, which has been enriched with the population data per commune. It will first be necessary to **the surface areas** of each municipality and then **divide the population by the surface area**:

- Open the Attribute Table of the Commune layer
- We will use the buttons above the table dedicated to editing the table:



- First click on the pencil to activate the edit mode, the other buttons then become accessible.
- Click on the Open Field Calculator button
- Choose create a new field for Population density as Decimal number
- Choose from the Fields and values list the attribute for Total population "popT"
- Choose the function: here in the Geometry list, double click on \$area
- Write the expression: "popT" / \$area \* 1000000 (multiply by 1 million to have the densities in sq. km)
- The output preview shows that the calculation is indeed consistent
- Click OK
- Finally click on the Pencil button to exit the editing mode and Save.



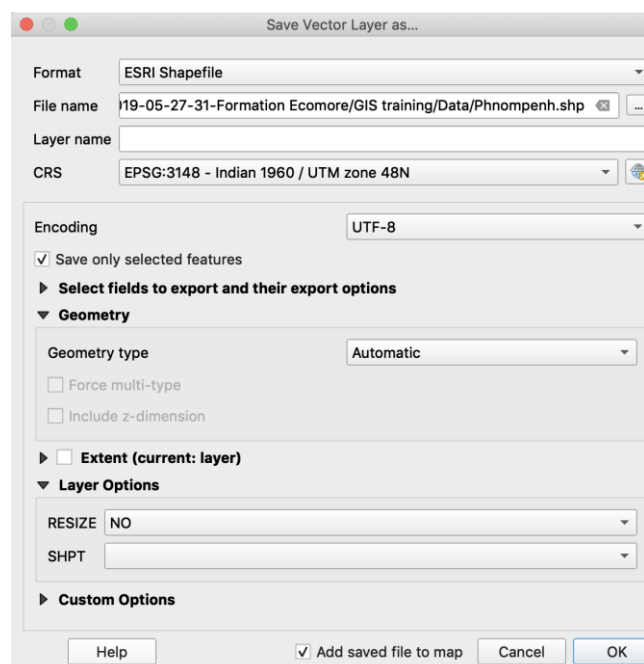
*Note: When you switch to edit mode of the attribute table, it is also the shapefile that can be modified.*

- Check consistency in the population field of the attribute table or by displaying on the map.

### 3.4. Creating a map from a selection of entities

#### Exercise: Create a map of Phnom Penh Municipality (province)

- Open the province shapefile: khm\_admbnda\_adm1\_gov\_20181004.shp
- Select Phnom Penh
- Right click on the layer name and choose Export / Save Selected Features As...
- Choose the ESRI format, the destination of your new shapefile, name it
- OK
- Zoom on the extent of this new map by right clicking on its name and choosing "Zoom to layer"

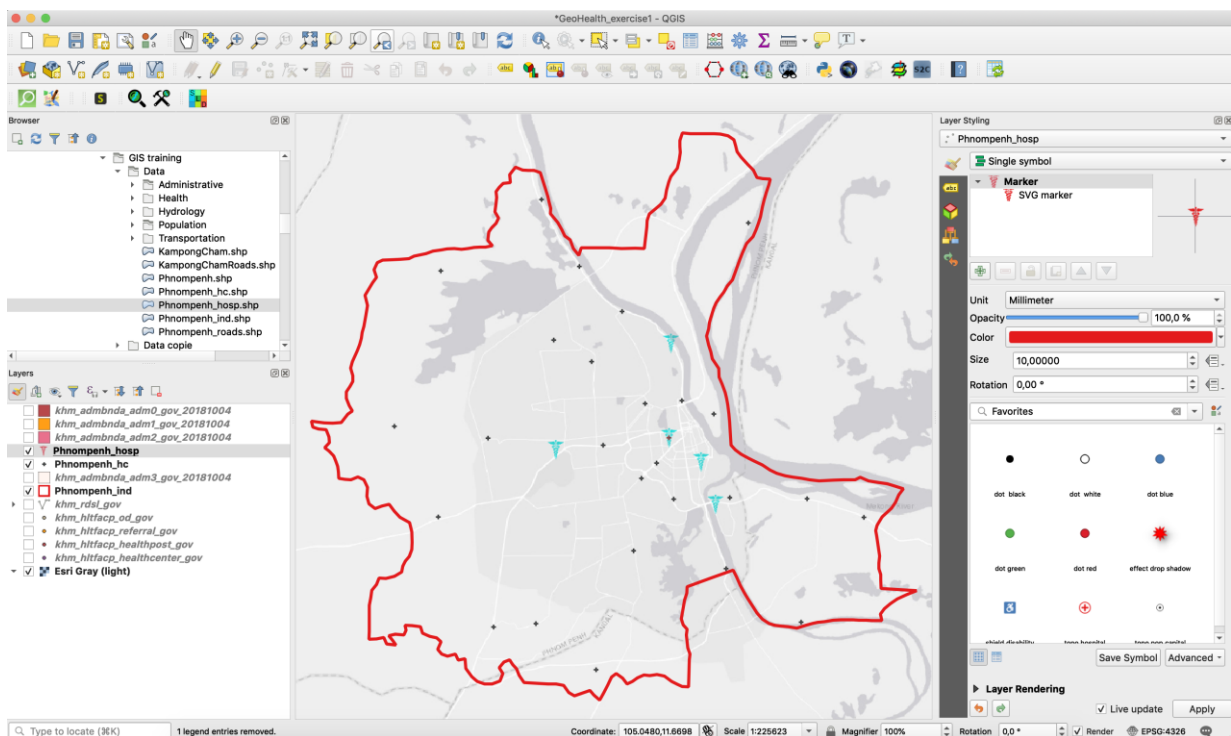
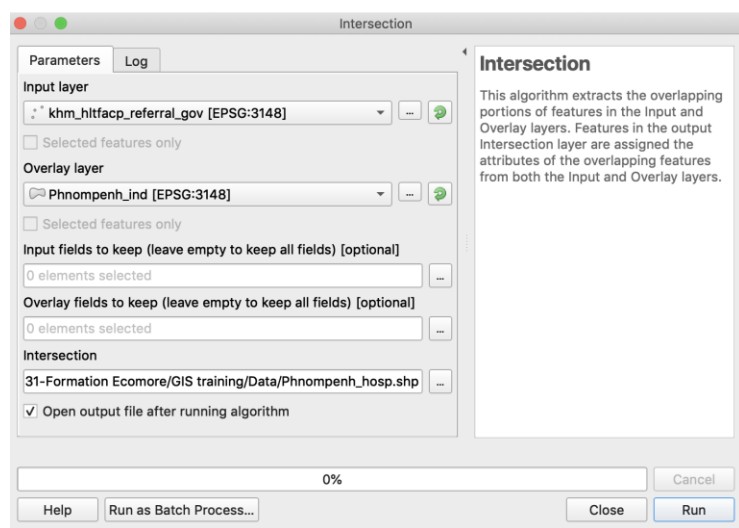
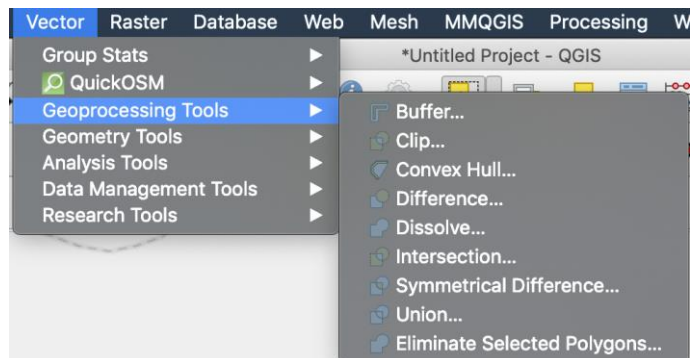


### 3.5. Intersecting vector layers

QGIS offers a set of geoprocessing tools available in the Vector menu.


**Exercise:** Extract health facilities in your province of interest (example of Phnom Penh)

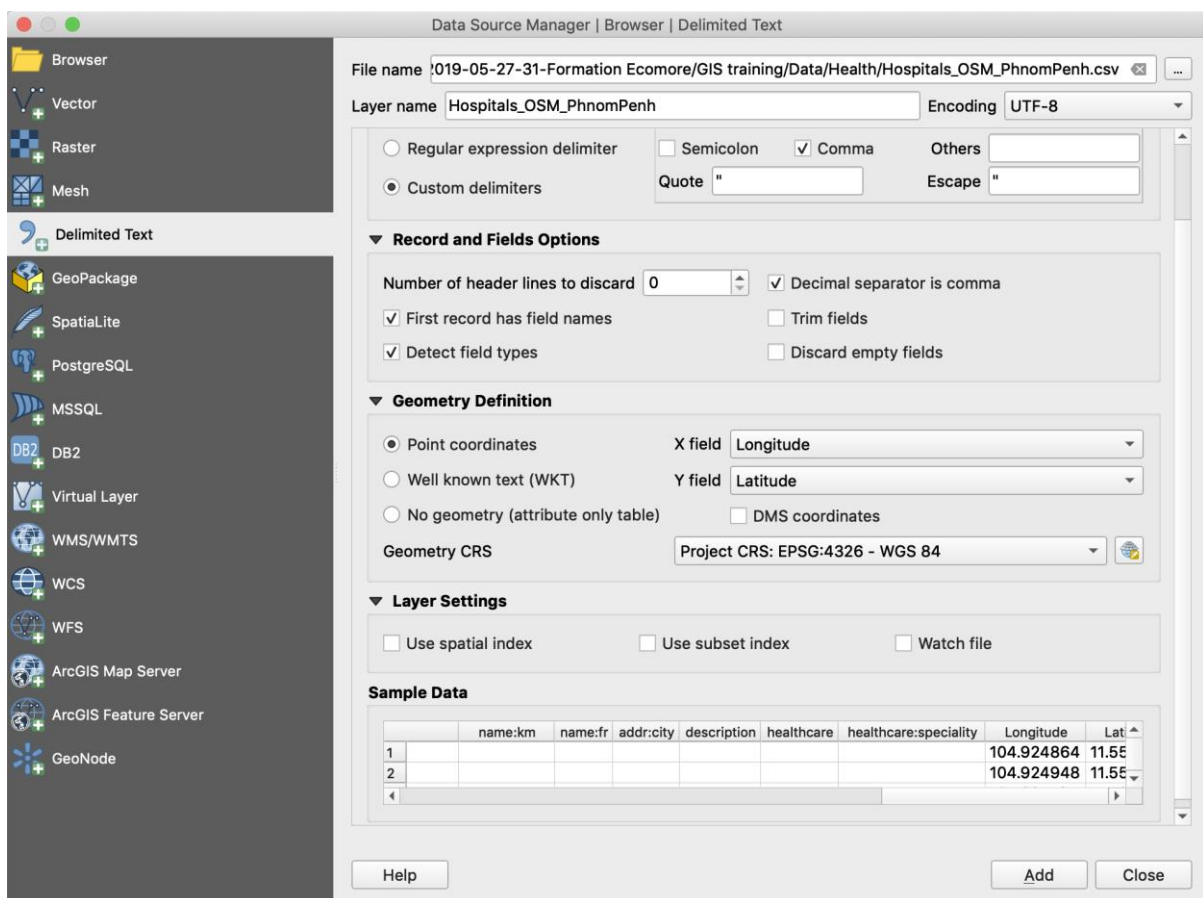
- Add the shapefiles of the referral hospitals and of the health centers to your map canvas and check their CRS (-> Indian 60 / UTM zone 48N)
- Add the shapefile of one province (here we take Phnom Penh) and check its CRS (-> WGS 84)
- Project this shapefile into the local projected CRS
- Go to the Vector Menu / Geoprocessing tools / Intersection...
- Input layer = khm\_hltfac\_referral\_gov.shp
- Overlay layer = Phnompenh\_ind.shp
- Intersection: browse to your folder and choose a name for the resulting intersection shapefile
- Run



### 3.6. Creating a layer from GPS coordinates

**Exercise: Create a shapefile from a csv file** containing the longitude and latitude of Phnom Penh hospitals (as referred in OpenStreetMap).

- Open the Data Source Manager , choose the “Delimited Text” tab and browse to your csv file: Hospitals\_OSM\_PhnomPenh.csv
- Precise the file format (here, we use custom delimiters and check Comma) -> the table should be readable in the “Sample Data” box
- Precise the geometry: check “Point coordinates” and indicate the X and Y fields
- Precise the CRS of these points
- Press “Add”
- Save these imported points as a shapefile: right-click on the name of the imported file, choose Export / Save features as...

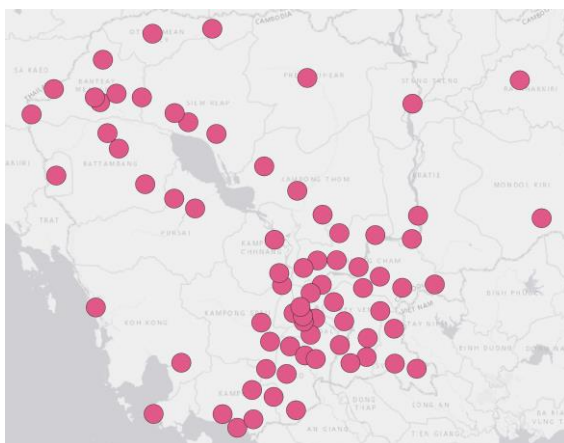
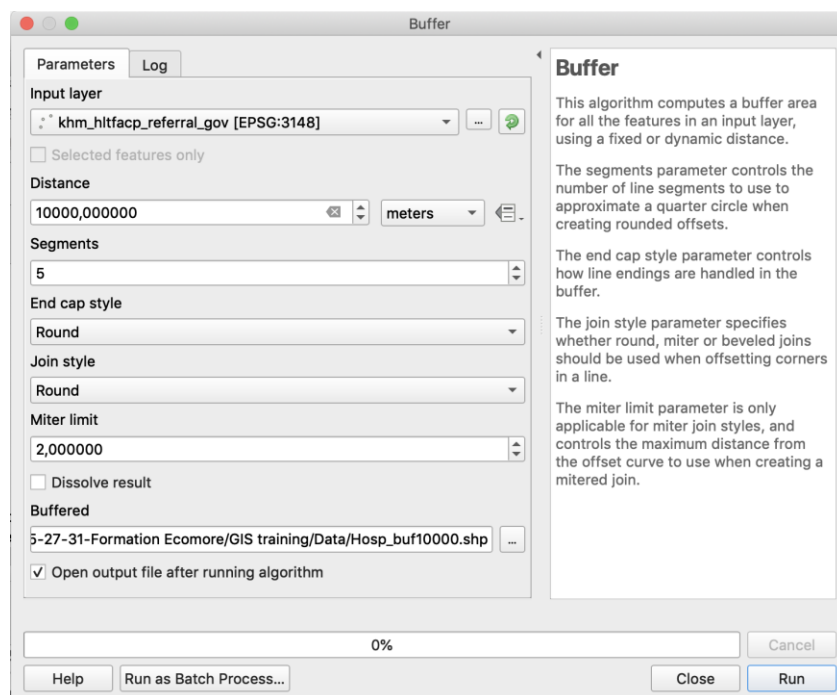


### 3.7. Creating buffer zones (buffers)

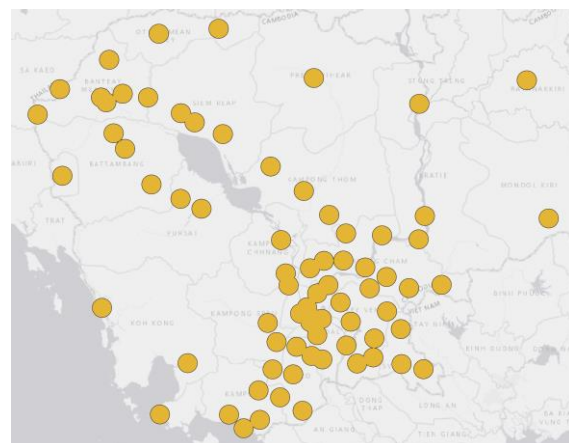
For the creation of buffer zones, we need a CRS in meters.

#### Exercise: Create buffers zones around health facilities

- Add the hospital layer to the canvas: khm\_hltfacp\_referral\_gov.shp
- Check its CRS (-> Indian 60 / UTM zone 48N)
- Go to Vector menu / Geoprocessing Tools / Buffer...
- Choose Distance (for example here 10 kms), whether the overlapping buffers are dissolved or not, and a place to save your Buffered shapefile
- Run



Example of separated buffers



Example dissolved buffers

**Note:** Buffer zones can be created from any type of vector file (points / lines / polygons). The buffer zones will always be polygons.



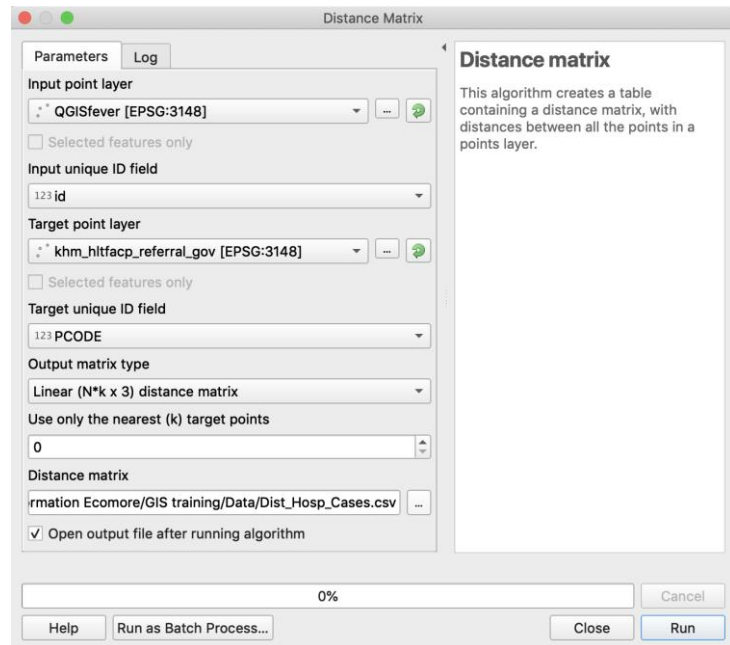
### 3.8. Calculating distances between points (distance matrices)

A dedicated QGIS function allows you to directly calculate distances between two layers of points.

**Exercise: Calculate the distances between the locations of the fictive patients (QGISfever.shp) and referral hospitals (khm\_hltfacp\_referral\_gov.shp).**

As with the creation of buffer zones, we need a CRS in meters to calculate distances.

- Go to Vector Menu / Analysis Tools / Distance Matrix...
- Choose the two point layers (containing n cases and m infrastructures)
- Choose the type of matrix:
  - Linear distance matrix where all combinations will be in line (n\*m lines)
  - Standard distance matrix (with n rows and m columns)
- Specify the name and location of the output distance matrix. This matrix will be in.csv format

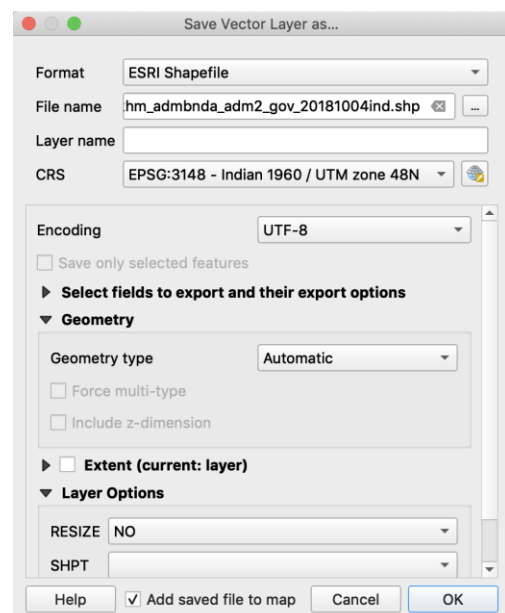


### 3.9. Calculating the number of points in a polygon

This function is very useful in epidemiology for calculating, for example, the number of cases per administrative unit.

**Exercise: Calculate the number of “QGIS fever” cases in each district of Phnom Penh**

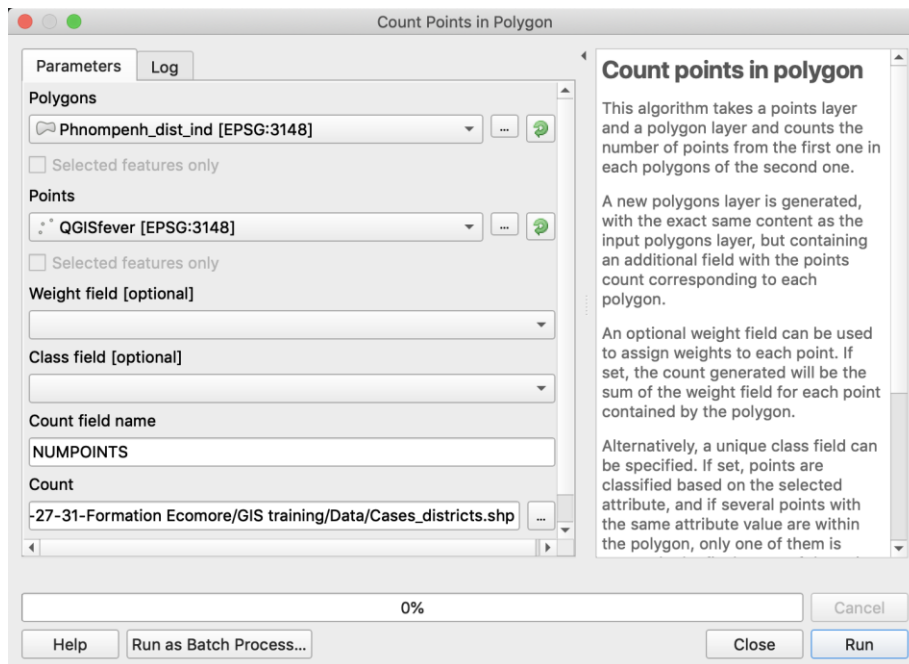
- Reproject the district layer in the local projected CRS (Indian 60 / UTM zone 48N)
  - Right-click on the name of the layer
  - Export / Save Features As...
  - Browse to your folder and give a new name indicated they are reprojected.
  - Choose the new CRS
  - OK
- Clip the district layer to the extent of Phnom Penh province:
  - Go to Vector Menu / Geoprocessing Tools / Clip...
  - Choose the district layer as the input layer
  - Choose the Phnom Penh layer as the overlay layer
  - Browse to your folder and give a name to the clipped layer
  - Run







- Analysis Tools / Count Points in Polygon...
  - Choose the district layer as Polygons
  - Choose the QGIS fever layer as Points
  - See the possible options to Weight fields (not used here)
  - Specify a file name and folder for your output shapefile.



You can then represent the number of cases in each district by playing with the symbology

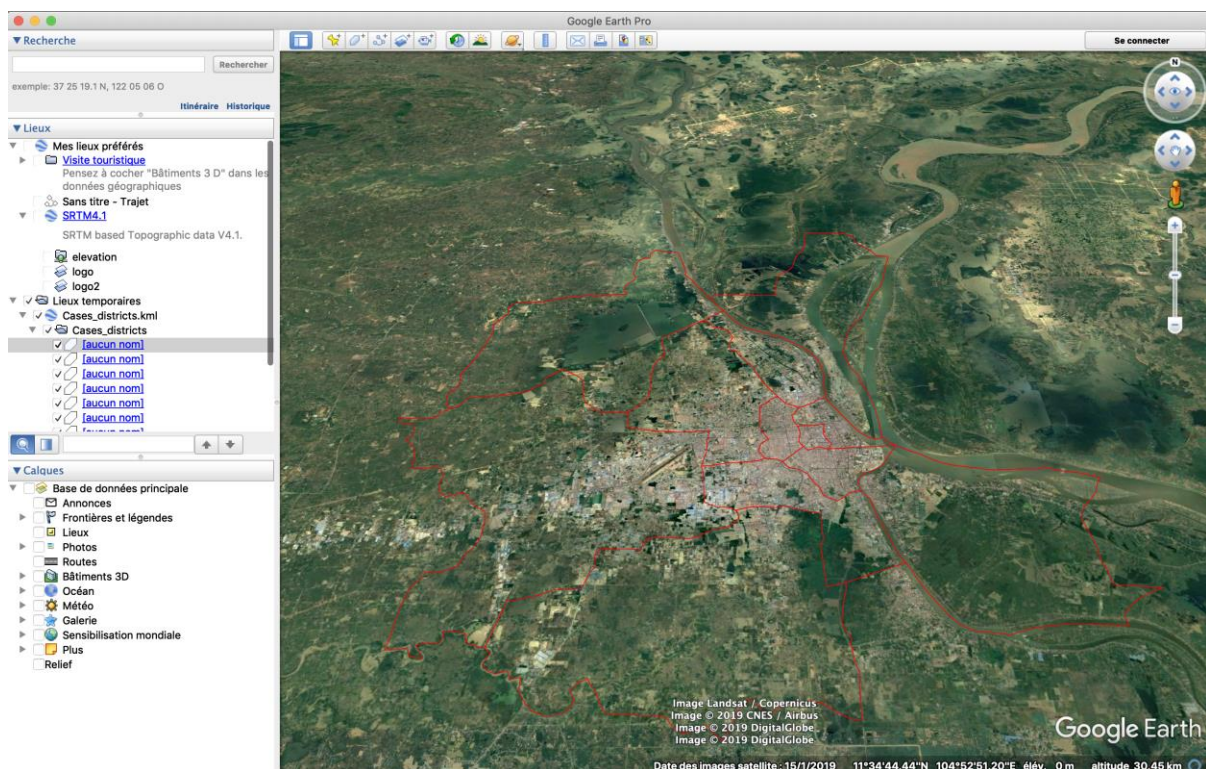
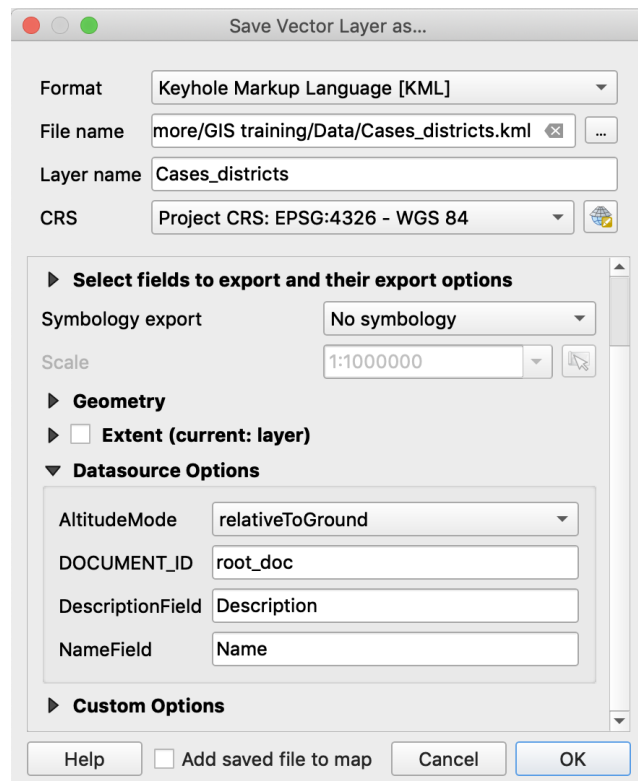


### 3.10. Exporting a layer to Google Earth

*Note:* This export could be useful when you want to exchange files with colleagues who do not know how to use a GIS, but who know the possibilities of Google Earth.

- Right-click on the name of your layer and choose Export / Save Features As...
- Choose the KML (Keyhole Markup Language) format
- Select the folder and name of your kml file to save
- OK


This kml file can be opened in Google Earth.

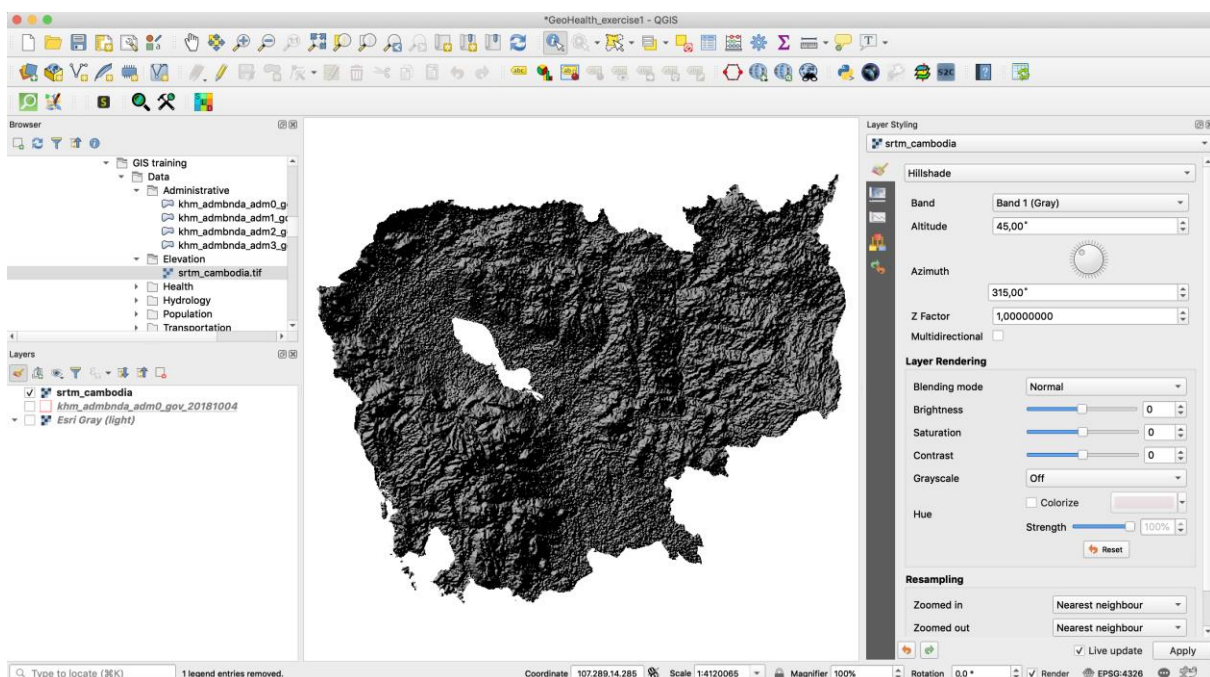


## 4. Using raster data

In this exercise, we will use a Digital Elevation Model (DEM), called SRTM (Shuttle Radar Topography Mission), provided by NASA and NGA (formerly NIMA).

### 4.1. Opening and displaying raster data

- Open the Data Source Manager , choose the “Raster” tab and browse to `srtm_cambodia.tif`
- Double-click on the name to open the Layer Properties, and go to the Symbology tab
- In Render type, choose “Hillshade” and Apply to view the Elevation data with shadow
- Try also the “Singleband pseudocolor” for a color view. You can adjust the classification mode and increase the number of classes. You can choose the color ramp and invert colors.

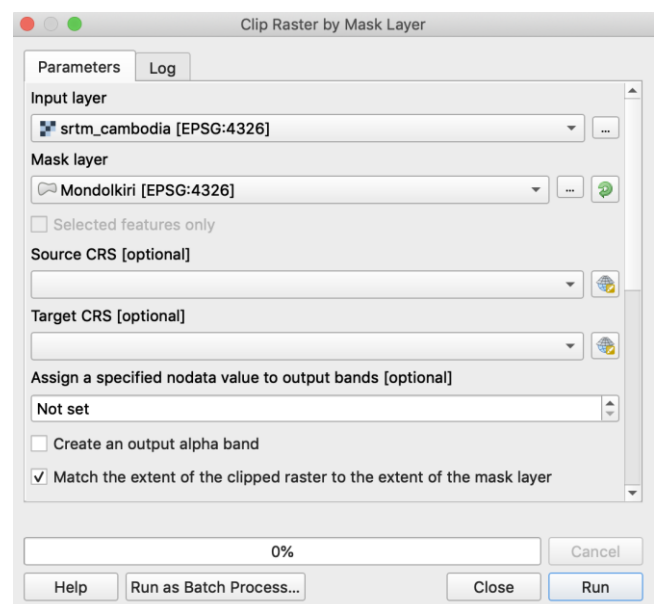


### 4.2. Clipping a raster

QGIS offers the possibility to cut a raster according to the contour of vector layers.

#### Exercise: Extract the SRTM on Mondolkiri province (east of Cambodia)

- Create a shapefile layer of Mondolkiri
  - Open the province layer: `khm_admbnda_adm1_gov_2018_1004`
  - Select Mondolkiri province
  - Right-click on the name of the layer / Export / Save Selected Features As...
  - Browse to your folder and save the Mondolkiri.shp layer



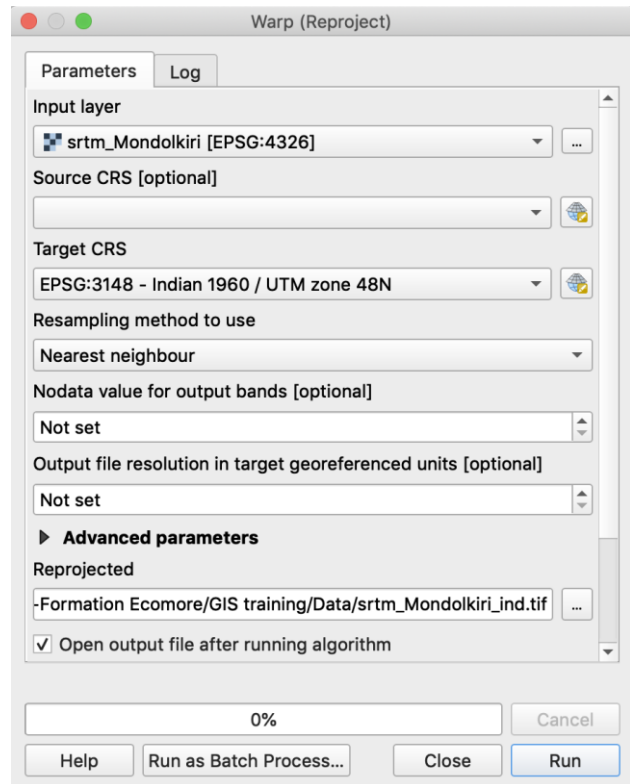
- Raster / Extraction / Clip Raster by Mask Layer...
- Input layer = srtm\_cambodia.tif
- Mask layer = Mondolkiri.shp
- Run

### 4.3. Changing the projection of a raster

The DEM srtm\_cambodia.tif is in WGS84 with units in decimal degrees. To make some calculations related to distances, we will need the meter as a unit. It is therefore necessary to reproject our raster.

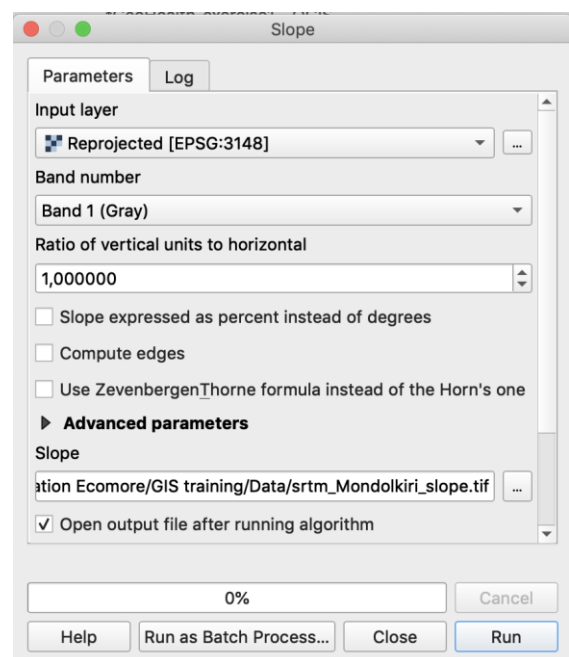
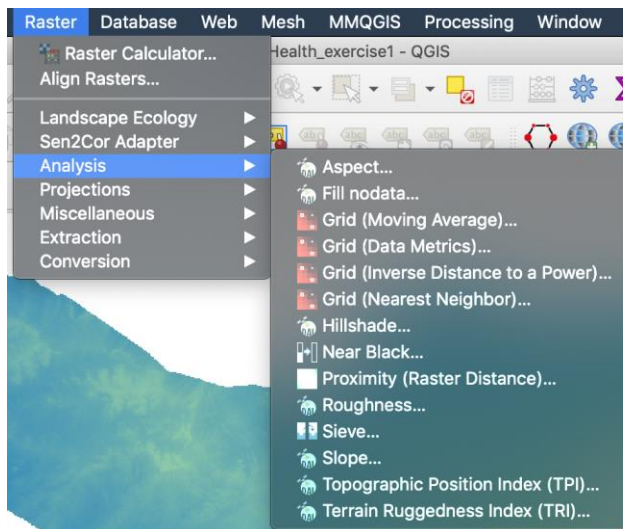
#### Exercise: Reproject the Mondkiri DEM in the local projected CRS

- Go to Raster Menu / Projections / Warp (Reproject)
- Input layer = srtm\_Mondkiri.tif
- Target CRS: choose the local projected CRS
- Browse to your folder and give a name to the Reprojected raster
- Run.



### 4.4. Deriving information from DEM: slopes, aspect, hillshading, contours

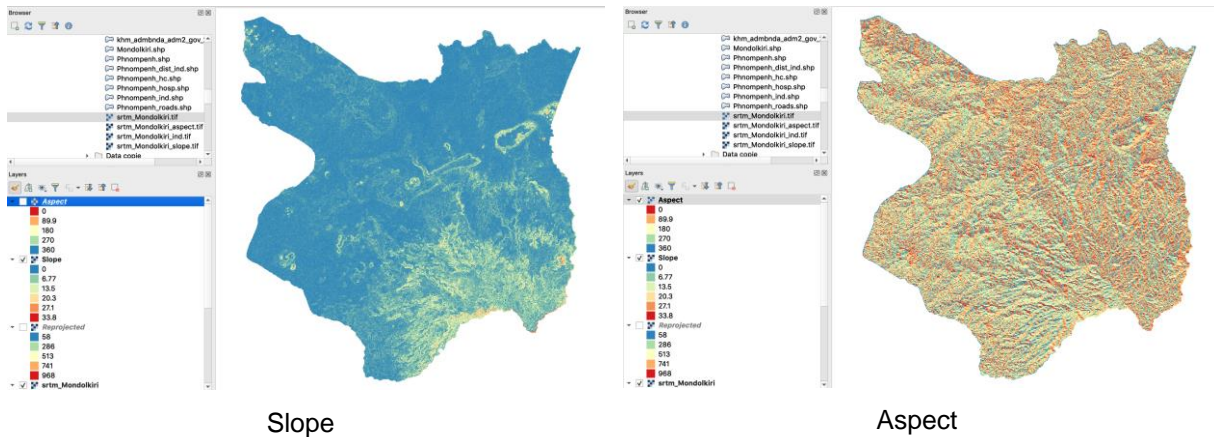
Several tools are provided in the Analysis Menu from the Raster Menu



### Exercise: Calculate slope and aspect in Mondolkiri province

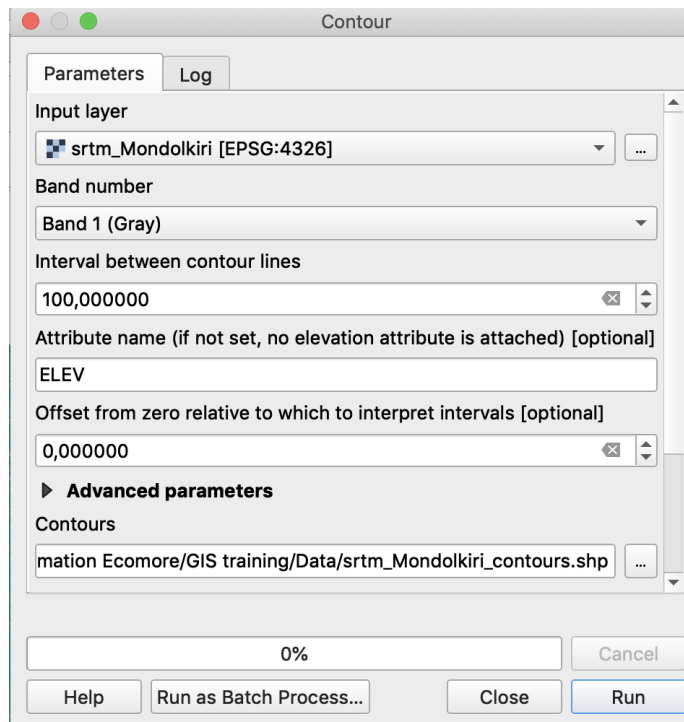
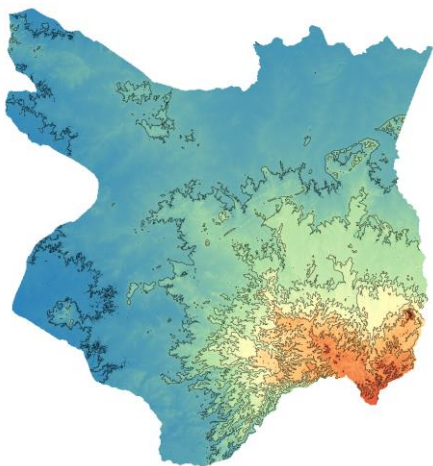
- Go to Raster Menu / Analysis / Slope...
- Choose the Mondolkiri DEM
- Browse to your folder and give a name to the raster of slopes
- Run
- The same applies to the calculation of exposure (aspect) and hillshading.

*Note: Calculating the slope in QGIS is simple. The output is also a raster of the same resolution (90 meters) as the source raster.*



### Exercise: Calculate the contour lines of Mondolkiri province

- Go to Raster Menu / Extraction / Contour...
- Choose the Mondolkiri DEM
- Choose the interval between lines = 100 meters
- Browse to your folder and give a name to the shapefile of contour lines
- Run

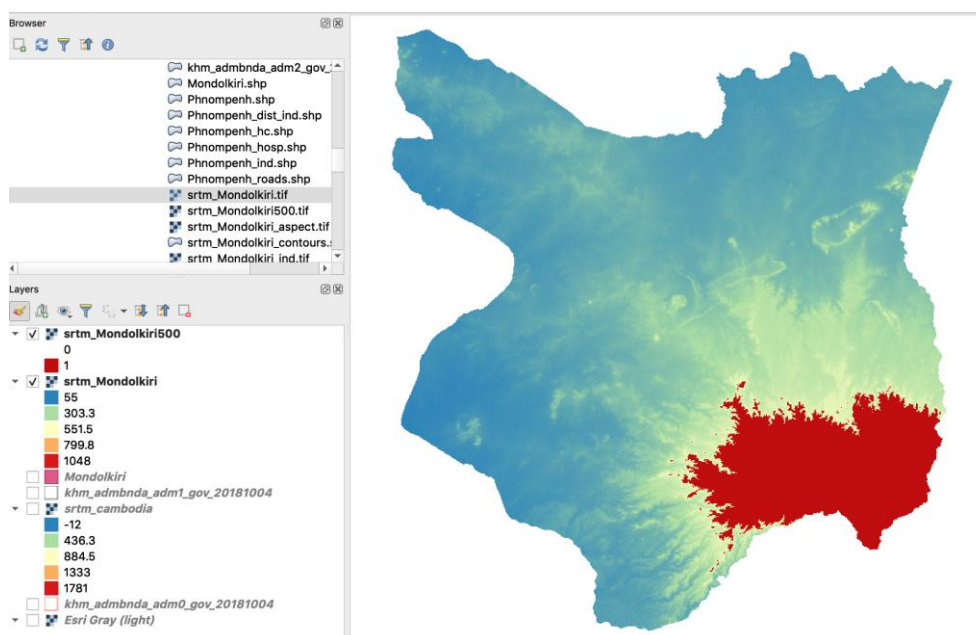
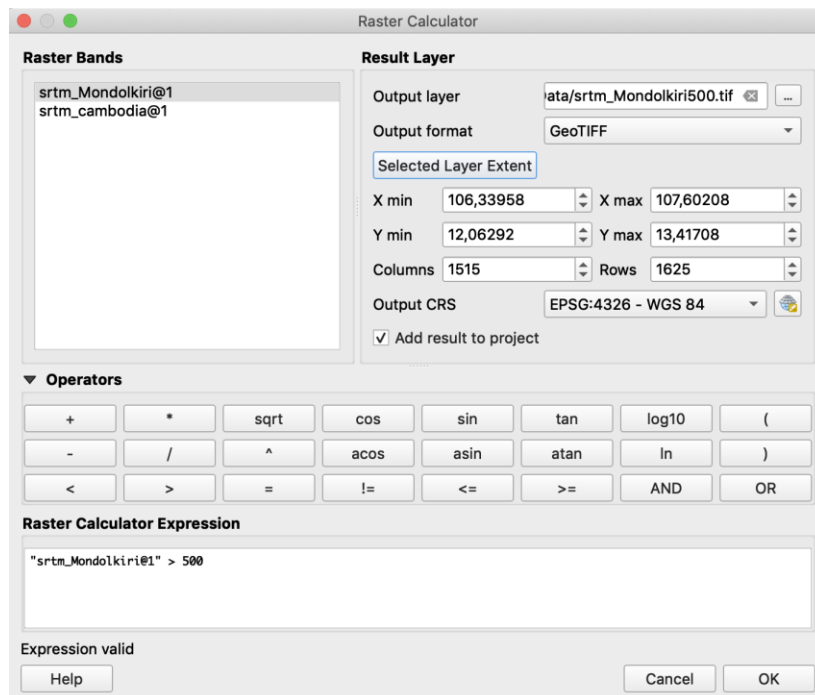


## 4.5. Raster calculator

The raster calculator allows you to make calculations between several rasters or on the values of a single raster.

### Exercise: extract the DEM over 500 meters high

- Open the raster calculator: Raster / Raster calculator...
- Select the Mondolkiri raster
- Browse to your folder and give a name for the output layer
- Raster Calculator Expression: Double-click the raster name in the “Raster Bands” list to enter its name in the expression then write “> 500”
- OK



## 4.6. Downloading and using Sentinel-2 images

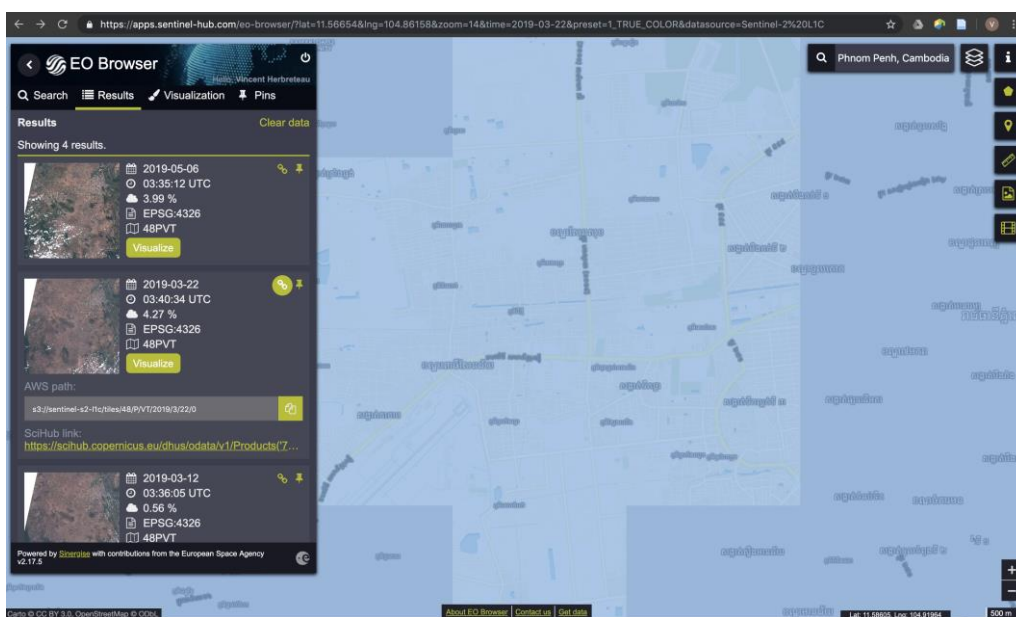
### Browse and download Sentinel-2 images

We will use here the EO Browser provided by Sentinel Hub and developed by Sinergise:

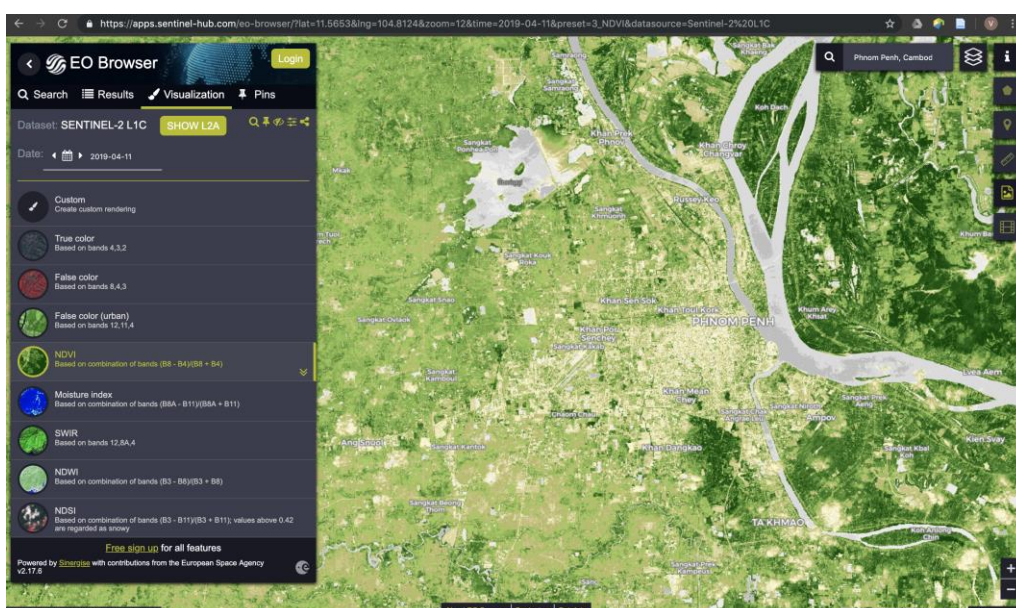
<https://apps.sentinel-hub.com/eo-browser/>


### Exercise: download and display a Sentinel-2 image from Phnom Penh

- Open the EO Browser and search for Phnom Penh in the top right search box. Zoom the map to Phnom Penh
- Choose Sentinel-2 L1C as Data source, reduce the maximum cloud coverage to 20%
- Choose a time range and search



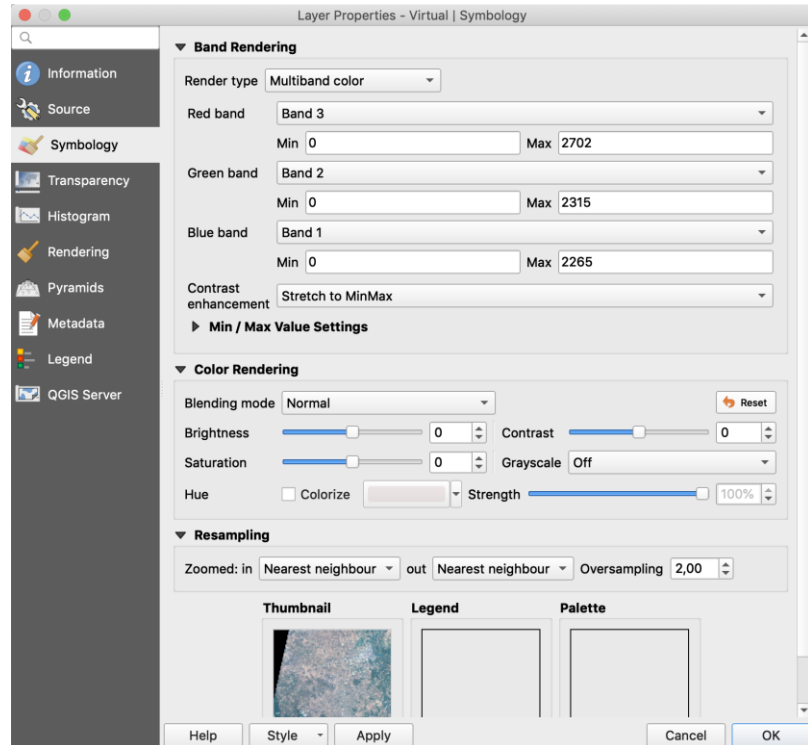
- Choose one tile among the results and click on Visualize
- Look at the different indices available to observe their distribution



- Click on the download icon  to get the weblink to download the chosen image
- Download requires to be registered in the Copernicus Open Access Hub (<https://scihub.copernicus.eu/>)

### Display a Sentinel-2 image in True color

- Add the raster bands of your Sentinel-2 images: Menu Layer / Add Layer / Add Raster Layer...
- Browse and choose the different bands to open B02 (Blue), B03 (Green) and B04 (Red)
- Miscellaneous / Build Virtual Raster...
- Choose the 3 input layers
- Run
- Open the layer properties of your virtual raster and go to Symbology tab
- Choose the correct bands for each color and click OK

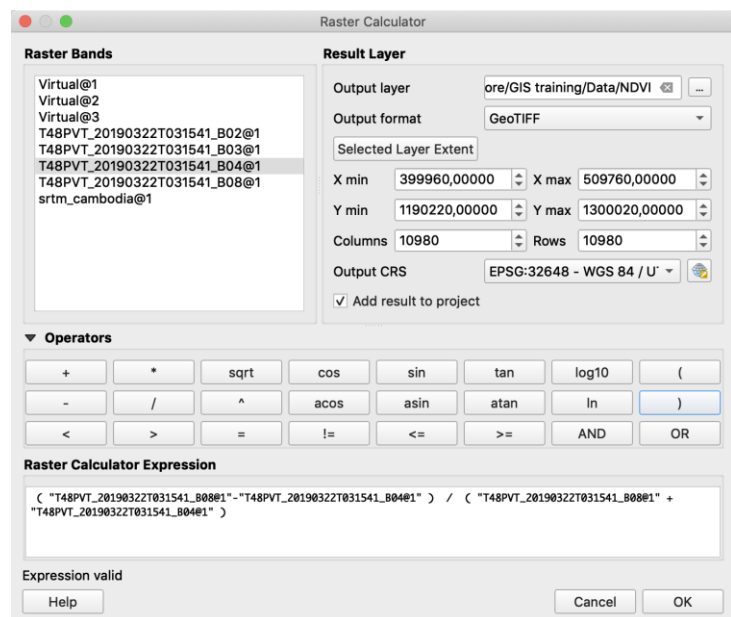


### Exercise: Calculate the NDVI of this Sentinel-2 image from Phnom Penh

The normalized difference vegetation index (NDVI) is a simple index that can be calculated from optical satellite images to show the vigor of vegetation.

$NDVI = (Near\ Infrared\ Band - Red\ Infrared\ Band) / (Near\ Infrared\ Band + Red\ Infrared\ Band)$

- Go to Raster / Raster Calculator
- Browse to your folder and give a name for the NDVI
- Write the equation of NDVI
- OK
- Open the layer properties of your NDVI and go to Symbology tab
- Select Render type = Singleband pseudocolor
- Choose a Red to Green color ramp and a method of classification
- OK





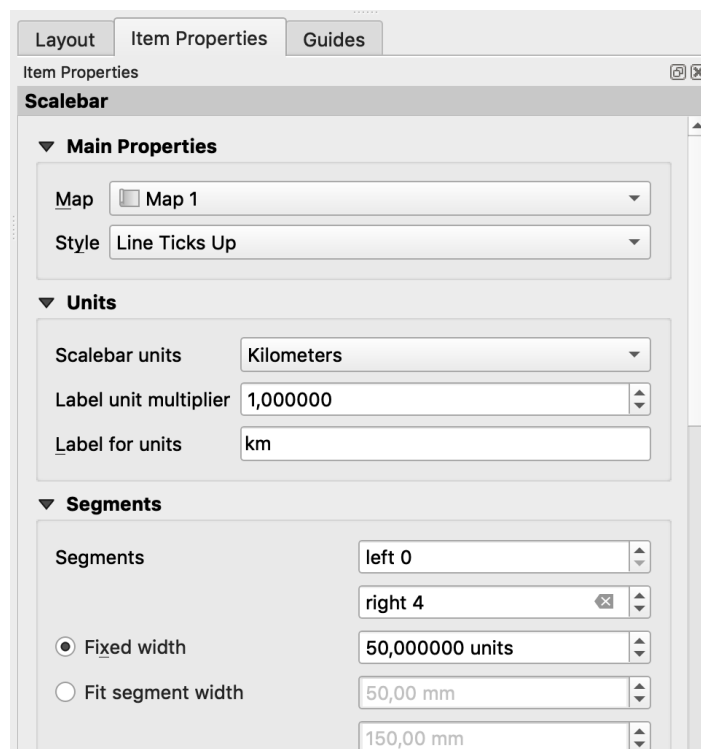


## 5. Composing map layouts

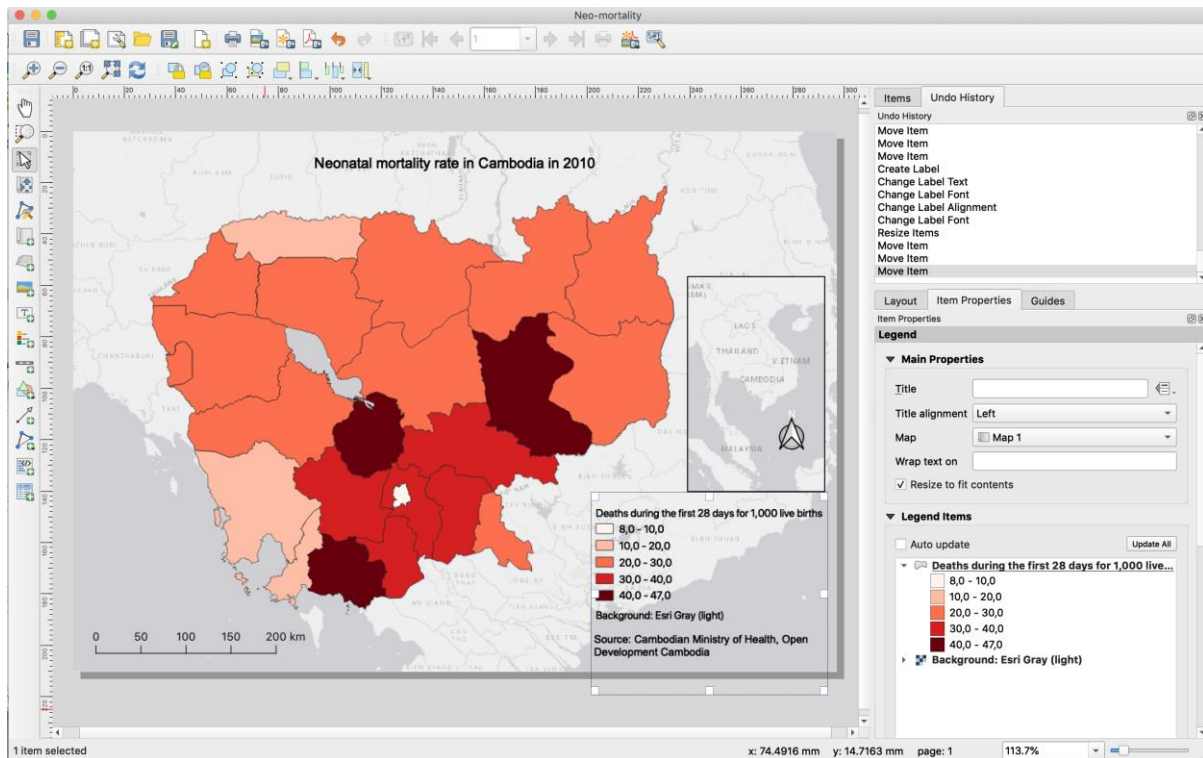
Map composition (layout) is realized in the Layout Composer.

**Exercise: Compose the map layout of neonatal mortality rate in Cambodia** (number of deaths during the first 28 completed days of life per 1,000 live births in a given year or period)

- First you need to render and symbolize your data in the map canvas as you want them to appear in a the map layout
- Create a Print Layout
  - Project / New Print Layout...
  - Give a name to your layout and click OK
  - A right-click on the white page allows to open Page properties and set up the page size (for example A4 landscape)
- Add your map:
  - Go to “Add item” Menu / Add Map or Click the button “Add a new map to the layout”  

  - Draw the extent of map on your canvas
  - The map from your QGIS is displayed
  - Use the “Move item content” button  to move you map within its box
  - You can check “Lock layers” and “Lock styles for layers” to fix your map
  - You can redo add map to add a second one. Then, you need to go back to GIS main window to choose the display of your map canvas you want to show in the second map
- Add a scale bar:
  - Go to “Add item” Menu / Add Scale Bar
  - Place your scale bar on the map
  - When the scale bar is selected, you can adjust its properties in the Item Properties window
  - Choose the style of the scale par in “Main properties”
  - Choose the Units: here: 1 km
  - Choose the number of Segments: here 50 units
  - You can further adjust fonts, margins, etc.



- Add a legend:
  - Go to “Add item” Menu / Add Legend
  - Place your legend on the map
  - When the legend is selected, you can adjust its properties in the Item Properties window
  - In the Legend items: uncheck “Auto update” to remove some parts of the legend or reorder
  - You can double-click on a layer name to modify it
  - You can further adjust fonts, margins, etc.
  - You can uncheck background for a transparent one
  
- Add a North arrow:
  - Go to “Add item” Menu / Add Picture
  - Place the picture on the map
  - In the “Search Directories”, look for a compass or North arrow
  
- Add Text for title, sources, etc.
  - Go to “Add item” Menu / Add Label



- Export maps:
  - In the Layout tab, should the export resolution (300 dpi is advised for fine printing)
  - Export as image or as pdf, depending on your needs

