



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).



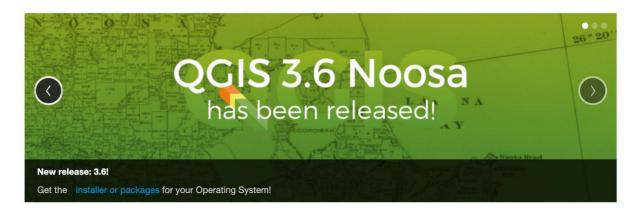
QGIS allows users to view, manage, edit and analyze spatial information, in addition to composing and exporting maps. Among GIS software, QGIS is simple to use and intuitive. When it was created, QGIS only offered the main functionalities, but it benefits from a very active community and is evolving 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 everincreasing 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: <u>http://docs.qgis.org/latest/en/docs/training_manual/index.html</u> QGIS Tutorials and tips, by Ujaval Gandhi.: <u>https://www.qgistutorials.com/en/</u> Introduction to GIS Fundamentals, by Datapolitan: <u>http://training.datapolitan.com/qgis-training/Introduction_to_GIS_Fundamentals</u>

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

For more information on GeoHealth researches, follow:

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





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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

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3.6.3 3.4.8 LTR	DISCOVER QGIS	FOR USERS	GET INVOLVED	DOCUMENTATION	Const				English	T
	Downloa	ad QGIS	S for your	r platform						
	Binary packages (i	nstallers) are ava	ailable from this page	е.						
	The current version	n is QGIS 3.6.3 '	Noosa' and was rele	ased on 17.05.2019.						
	The long-term repo	ositories currentl	ly offer QGIS 3.4.8 'N	Madeira'.						
	QGIS is available of	on Windows, Ma	cOS X, Linux and Ar	ndroid.						
	We are currently in	feature freeze p	receeding the releas	se of QGIS 3.8. Please	consider testing the p	prereleases. See road ma	р.			
	INSTALLATION	DOWNLOADS	ALL RELEASES	SOURCES						
	Download fo	or Windows						<		
	QGIS in OSC	5								
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	± -{	🌮 osg	eo4W Network Inst	taller (32 bit)			ď			
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					Advanced Install and I and select ggis-dev-					
			OSGeo4W package		and select qgia-dev-	-un				
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	_			ler Version 3.6 (64 bit)			a'			
		nd5								

The installation does not raise any particular difficulties

Q QGIS 3.6.3 'Noosa' Setup		QGIS 3.6.3 'Noosa' Setup
DOOTHARABAH	Welcome to the QGIS 3.6.3 'Noosa' Setup Wizard	Choose Components Choose which features of QGIS 3.6.3 'Noosa' you want to install.
	This wizard will guide you through the installation of QGIS 3.6.3 'Noosa'.	Check the components you want to install and uncheck the components you don't want to install. Click Install to start the installation.
36	It is recommended that you dose all other applications before starting Setup. This will make it possible to update relevant system files without having to reboot your computer. Click Next to continue.	Select components to install: North Carolina Data Set South Dakota (Spearfish) Alaska Data Set
Noosa		Space required: 1.7GB
1 (marke annun s	Next > Cancel	Nullsoft Install System v2.50





1.2. Starting QGIS

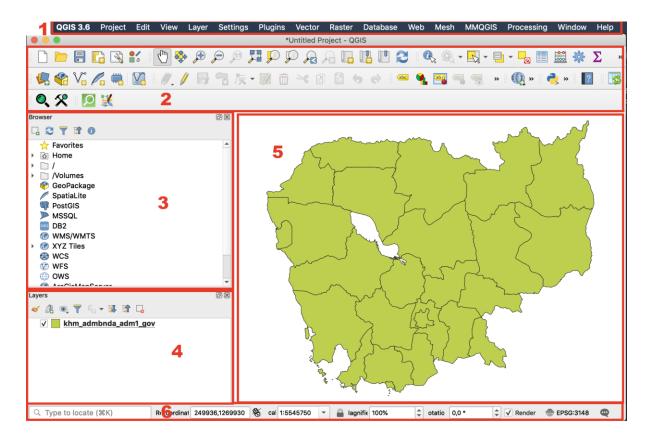
• Use the QGIS shortcut on desktop :



• 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







Panels	Advanced Digitizing Pane	Selected Layers		Advanced Digitizing Toolbar
Toolbars ► Toggle Full Screen Mode F11 Toggle Panel Visibility ℜ→ı Toggle Map Only ☆ℜ→ı	 Browser Panel Browser (2) Panel GPS Information Panel Layer Order Panel Layer Styling Panel Layers Panel Log Messages Panel Overview Panel Processing Toolbox Panel Results Viewer Panel Search QMS Panel Spatial Bookmarks Panel Statistics Panel Tile Scale Panel Undo/Redo Panel 	Panels Toolbars Toggle Full Screen Mode Toggle Panel Visibility Toggle Map Only	▶ F11 第→1 ①第→1	 Attributes Toolbar Data Source Manager Toolb Database Toolbar Digitizing Toolbar Help Toolbar Label Toolbar Manage Layers Toolbar Mugins Toolbar Project Toolbar Shape Digitizing Toolbar Vector Toolbar Web Toolbar SentinelHub SLD4raster dzetsaka QuickOSM
		Ready	Coordinate	SrtmDownloader

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

• • •	Options General		
۹	▼ ✓ Override system locale		
Ceneral	User Interface Translation		•
💸 System	Locale (numbers, date and currency formats) French France (fr_FR)		-
🌐 CRS	Show group (thousand) separator		
Data Sources	Note: Enabling / changing override on locale requires an application restart		
🞸 Rendering	Detected active locale on your system: fr_FR Sample date: 21/05/2019 money: 1000,00 € int: 1000 float: 1000,00		
🛃 Canvas & Legend	▼ Application		
🙀 Map Tools	Style (QGIS restart required)	Fusior	n -
Colors	UI Theme (QGIS restart required)	default	•
💓 Digitizing	Icon size		24 👻
Layouts	Font Qt default Abadi MT Condensed Extra Bold	▼ Size	13 ‡
🔁 GDAL	Timeout for timed messages or dialogs		5s ‡
~	Hide splash screen at startup		
Variables	Use native color chooser dialogs Modeless data source manager dialog		
Authentication	✓ Check QGIS version at startup		
Network			
Q Locator	▼ Project files		
🕂 Advanced	Open project on launch Welcome Page 👻		
Acceleration			
	Create new project from default project Set current project as default Reset default		
	Template folder //Users/Herbreteau/Library/Application Support/QGIS/QGIS3/profiles/default/project_templates		-
		Cancel	ок

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

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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

- <u>khm_admbnda_adm0_gov_20181004.zip</u> (127.0K)
- <u>khm_admbnda_adm1_gov_20181004.zip</u> (292.6K)
- <u>khm_admbnda_adm2_gov_20181004.zip</u> (589.2K)
- <u>khm_admbnda_adm3_gov_20181004.zip</u> (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-Perenial/Intermittent/Fluctuating" and "Perennial/Permanent"), lakes

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





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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



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2.2. Creating a project

QGIS starts with an untitled project but displays in the canvas the list of recent projects. By doubleclicking 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...



Note: Remember to frequently save your project!

2.3. Adding a vector layer

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

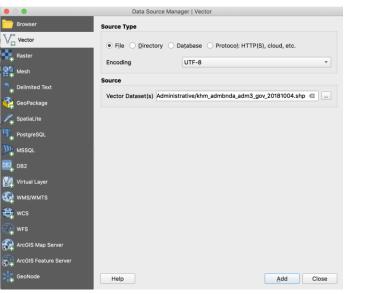
- Add the four levels of Cambodian administrative layers (provinces, districts, communes) to the project:
 - khm_admbnda_adm0_gov_20181004.shp (country)
 - khm_admbnda_adm1_gov_20181004.shp (provinces)
 - khm_admbnda_adm2_gov_20181004.shp (districts)
 - khm_admbnda_adm3_gov_20181004.shp (communes)

There are several ways to add data to the project

- 1. By using the Data Source Manager
 - a. Open the Data Source Mangager by clicking on its icon in the Data Source Manager Toolbar



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



- 2. By using the **Browser panel**
 - a. Find the .shp files in your folders
 - b. Double-click the .shp files directly or drag and drop it to the map canvas
- 3. 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





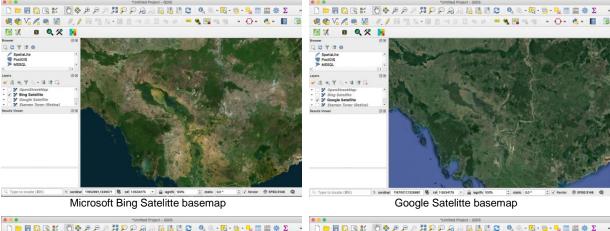


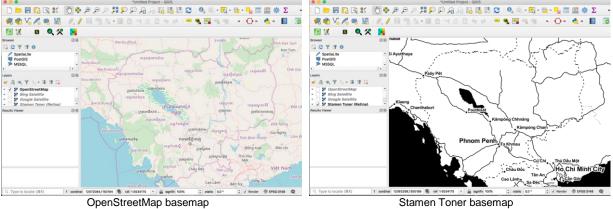


2.4. Adding a basemap

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:





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**:

	F	Plugins All (440)		
🏠 All	Q Search			
Installed	QRectangleCreator so qtranus	^î QuickMa	pServices	0
hot installed	Quick Attribution	Collection of e	easy to add basemaps	
💝 Upgradeable	QuickMapServices QuickMultiAttributeEdit3		f services + search for finding datasets and ervices via http://qms.nextgis.com! Built by	
Install from ZIP	VickOSM	****	50 rating vote(s), 1037232 downloads	
💺 Settings	😩 QuickWKT	Tags	service, internet, tms, wms, qms, wfs, g openstreetmap, osm, basemap	eojson,
	🖕 QWater 🏠 QWeather	More info Author	homepage bug tracker code repository NextGIS	Y
	🖕 QWeb	Installed version Available version		
	🝅 raster inversor	Changelog	0.19.10 * Set qgisMaximumVersion to 3.99 0.19.9	
	🍲 RasterDataPlotting		* Fix no native tile layer property dialog #162	
	SasterTimeseriesManager	✓ Upgrade All	Uninstall Plugin	Reinstall Plugin
	Help			Close







- 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)

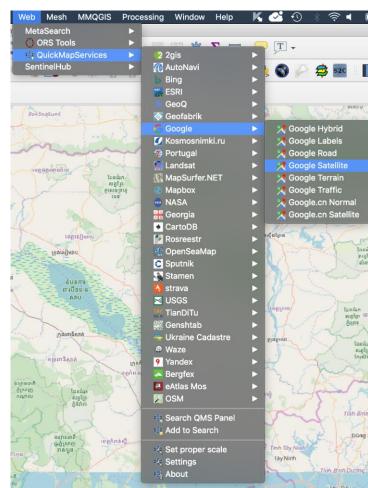
-> this plugin will be installed in the Web Menu

- 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/addbasemaps-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=%7
 Bz%7D

nnection Details	
lame	
JRL	http://example.com/{z}/{x}/sp.png
uthentication	
Configurations	Basic
Choose or create	an authentication configuration
No authentication Configurations st	n 🔪 🖉 🖶
Configurations st database.	ore encrypted credentials in the QGIS authentication
Configurations st	ore encrypted credentials in the QGIS authentication



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

- Copy the script here: <u>https://raw.githubusercontent.com/klakar/QGIS_resources/master/collections/Geosupportsyst</u> <u>em/python/qgis_basemaps.py</u>
- 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	0 X
🍾 🍓 📄 🔧 🔳	
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 folowing 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

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.

Scale	1:10000000	•

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

Coordinate:	11607123,951355	8

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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:
 - Select Feature(s),
 - Select Features by Polygon / by Freehand / by Radius
 - Select Features by Value
 - 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.

• • •	Statistics
khm_popa_com_c	cdb_2011
1.2 FAMILY	
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
Selected features	only

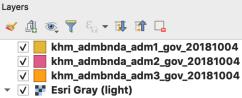
2.7. Adjusting the symbology

- 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



Layer Properties - khm_admbnda_adm1_gov | Symbology

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



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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

	0	Project Properties General			
2		▼ General Settings			^
R	General	Project file			
7	Metadata	Project home			
	CRS	Project title			
~	Default Styles	Selection color			
		Save paths relative -			
	Data Sources	Avoid artifacts when project is rendered as map tiles (degrades performance)			
'n	Relations	▼ Measurements			
	Variables	Ellipsoid (for distance and area calculations) WGS 84		-	
٩	Macros	(for distance and area calculations) Semi-major 6378137,000 Semi-minor 6356752	2,314		
	QGIS Server	Units for distance measurement Meters		-	
		Units for area measurement Square meters		*	
		▼ Coordinate Display			
		Display coordinates using Map units (meters)		-	1
		Precision Automatic Manual decimal places			
		▼			
					-
		Generate Project Translation File			-
		Help Apply	Cancel	ОК	

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.

	Project Properties General							
Q	▼ General Settings		-					
🔀 General	Project file							
📝 Metadata	Project home							
💮 CRS	Project title							
🤝	Selection color Background color							
	Save paths relative -							
Data Sources	Avoid artifacts when project is rendered as map tiles (degrades performance)							
Relations	▼ Measurements							
2 Variables	Ellipsoid (for distance and area calculations) WGS 84							
Diacros	Semi-major 6378137,000 Semi-minor 6356752,314							
QGIS Server	Units for distance measurement Meters	Meters						
	Units for area measurement Square meters	-						
	▼ Coordinate Display							
	Display coordinates using Map units (meters)	•						
	Precision Automatic Manual decimal places							
	Project Predefined Scales							
	Generate Project Translation File		Ŧ					
	Help Apply Cancel	ОК						



lacksquare





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:

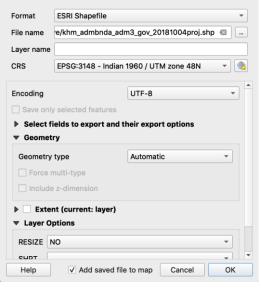
- Check the CRS of your administrative files (WGS 84).
- Reproject them into Local projected CRS (Indian 60 / UTM zone 48N):
 - Right-click on the name of the layer
 - Export / Save Features As...
 - Browse to your folder and give a new name indicated they are reprojected.
 - Choose the new CRS
 - **OK**

Specify the SCR of a project:

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

Coordinate Reference	e System Selector
Define this layer's coordinate reference s This layer appears to have no projection specification. By defa project, but you may override this by selecting a different proj	ult, this layer will now have its projection set to that of the
Filter Q	
Recently used coordinate reference systems	
Coordinate Reference System	Authority ID
* Generated CRS (+proj=longlat +ellps=walbeck +no_defs)	USER:100024
* Generated CRS (+proj=longlat +ellps=WGS60 +no_defs)	USER:100023
* Generated CRS (+proj=longlat +ellps=SGS85 +no_defs)	USER:100022
* Generated CRS (+proj=longlat +ellps=SEasia +no_defs)	USER:100021
 Generated CRS (+proj=longlat +ellps=plessis +no_defs) 	USER:100020
* Generated CRS (+proj=longlat +ellps=sphere +no_defs)	USER:100019
* Generated CRS (+proj=longlat +ellps=new_intl +no_defs)	USER:100018
* Constant ODC (into langlat i allos - NN/I OD i na dafa)	LICED:100017
Coordinate reference systems of the world	Hide deprecated CRS
Coordinate Reference System	Authority ID
Indian 1954 / UTM zone 46N	EPSG:23946
Indian 1954 / UTM zone 47N	EPSG:23947
Indian 1954 / UTM zone 48N	EPSG:23948
Indian 1960 / UTM zone 48N	EPSG:3148
Indian 1960 / UTM zone 49N	EPSG:3149
Indian 1975 / UTM zone 47N	EPSG:24047
Indian 1975 / LITM zone 48N	FPSG:24048
 Indian 1960 / UTM zone 48N Extent 102.14, 8.50, 108.00, 23.33 Proj4 +broj=utm +zone=48 +a=6377276.345 +b=6356075.41314024 +towgs84=198,881,317,0,0,0,0 +units=m +no_defs 	ANY ANY
Help	Cancel OK

Save Vector Layer as...









3. Using vector data

3.1. Downloading OpenStreetMap data

OpenStreetMap (OSM: 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
 - o 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

			QuickOSM		
7	Quick query	Help with key/value		Reset	
<i>(</i>	Query	Кеу	amenity		-
-	OSM File	Value	hospital		•
\geq	Parameters	In 🔹	Cambodia		
1	About	Advanced			
		Show of	query Running query		
		Parsing layer : multip	oolygons		

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

For administrative boundaries, check here the administrative levels by country: <u>https://wiki.openstreetmap.org/wiki/Tag:boundary%3Dadministrative#10_admin_level_values_for_spe_cific_countries</u>







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 ⁴, 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".

		Data S	ource Manager Bi	rowser Delimited Te	ext				
Browser	File name	ns/2019/	2019-05-27-31-Fo	rmation Ecomore/GI	S training/Da	ta/Population/	khm_pop_20	16_adm3_v2	.csv 🖾
Vector	Layer nam	Layer name khm_pop_2016_adm3_v2 Encoding UTF-8							
Raster	▼ File Format								
Mesh	• cs	CSV (comma separated values) Tab Colon Space							
Delimited Text	O Re	egular expr	ession delimiter	Semicolon	VC	omma	Others		
GeoPackage	• Cu	Custom delimiters Quote					Escape	•	
SpatiaLite	▼ Rec	ord and Fi	elds Options						
PostgreSQL	Numb	per of head	er lines to discard	0	✓ Decin	nal separator is	comma		
MSSQL	✓ First record has field names Trim fields								
DB2	✓ De	etect field t	ypes		Disca	rd empty fields	3		
Virtual Layer	▶ Geo	metry Def	inition						
WMS/WMTS	▼ Laye	er Settings	•						
wcs	🗆 Us	se spatial in	idex	Use subset in	ndex	V	Natch file		
WFS	Sample	Data							
		Commune	Province	ADM1_EN	Distric			field_6 field_	7 field_8 *
	1 10			Banteay Meanchey Banteay Meanchey					
ArcGIS Map Server	2 10	0202 F							
ArcGIS Map Server ArcGIS Feature Server	2 10 3 10 4			Banteav Meanchev					w F

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.

		Layer Prop	perties -	khm_pop	_2016_adm3_	v2 Sourc	e Fields				
2		8 🖊 🔳									
information	ld 🔺	Name	Alias	Type	Type name	Length	Precision	Comment	WMS	WFS	-
	abc 13	ADM2_EN		QString	text	0	0		✓	✓	
Source	abc 14	ADM2_PCODE		QString	text	0	0		v	✓	
ኛ Symbology	abc 15	ADM3_EN		QString	text	0	0		v	✓	_
be Labels	abc 16	ADM3_PCODE		QString	text	0	0		v	✓	
Diagrams	123 17	м		int	integer	0	0		v	✓	
3D View	123 18	F		int	integer	0	0		v	✓	
	123 19	т		int	integer	0	0		v	v	
Source Fields	123 20	M_00_05		int	integer	0	0		V	v	
Attributes Form	123 21	M_05_10		int	integer	0	0		V	v	
Joins	123 22	M_10_15		int	integer	0	0		v	✓	
Auxiliary Storage	123 23	M_15_20		int	integer	0	0		v	✓	
Actions	123 24	M_20_25		int	integer	0	0		v	v	
	123 25	M_25_30		int	integer	0	0		V	v	
Display	123 26	M_30_35		int	integer	0	0		V	v	
Rendering	123 27	M_35_40		int	integer	0	0		v	v	
Variables	123 28	M_40_45		int	integer	0	0		v	v	
🔰 Metadata 🗸 🗸	He	lp Style -	App	ly					Cancel		ок

- 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

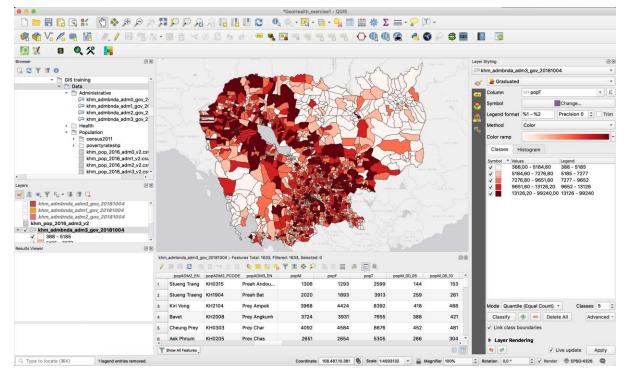




- b. Join field = ADM3_PCODE
- c. Target field = ADM3_PCODE
- d. Check the "Custom Field Name Prefix" and choose a short prefix such as "pop", otherwise the name of the joined attributes will be too long
- e. OK

Setting Val	ue	Add Vector Join
information	Join layer	khm_pop_2016_adm3_v2 ~
Source	Join field	abc ADM3_PCODE
Symbology	Target field	abc ADM3_PCODE
abels	✓ Cache join layer i	n virtual memory
agrams	Create attribute in	ndex on join field
) View	Dynamic form	
	Editable join	-
rce Fields	▼	
ibutes Form	C_Commune Province	<u>^</u>
ins	ADM1_EN District Commune	
kiliary Storage		
ions		Name Pretix
play	pop	
		Cancel OK
ndering		
ables 🖷 🚍		
edata Help	Style - Apply	Cancel

- 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 for 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.

oreate a new ne	ld		Update existing field
Create virtual fie	ld		
Output field name	POP_DENS		
Output field type Decimal number (real		•	
Output field length	10	4 \$	
Expression Fun	ction Editor		
= + + - / / * "popT" / Sarea *	▲ II () '\n' • 1000000	 Conditio Conversion Date an Fields a Fuzzy N General Geometiangli Sarea azim bour 	io. Returns the area of the current d. feature. The area calculated by rd. this function respects both the at. current project's ellipsoid setting and area unit settings. ry For example, if an ellipsoid has a calculated area will be ellipsoidal, and if no ellipsoid is ut set then the calculated area will

Field Calculator

• 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_20181 004.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"

		Save Vector Layer as					
Format File name Layer name	ESRI Shapefil 19-05-27-31-	le -Formation Ecomore/GIS training/Data/Phnompenh.shp	•				
CRS							
Encoding		UTF-8	•				
		ures t and their export options					
Geometry	type nulti-type	Automatic	•				
	z-dimension						
▶ Exter ▼ Layer O	nt (current: la ptions	yer)					
RESIZE N SHPT	10		•				
Custom	-	C Add annud file to man. Oursel	OK				
He	ip	Add saved file to map Cancel	OK				









Mesh MMQGIS Processing

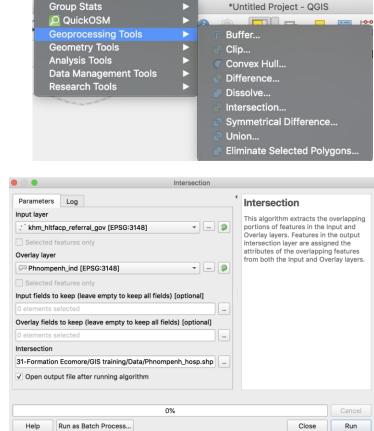
3.5. Intersecting vector layers

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)

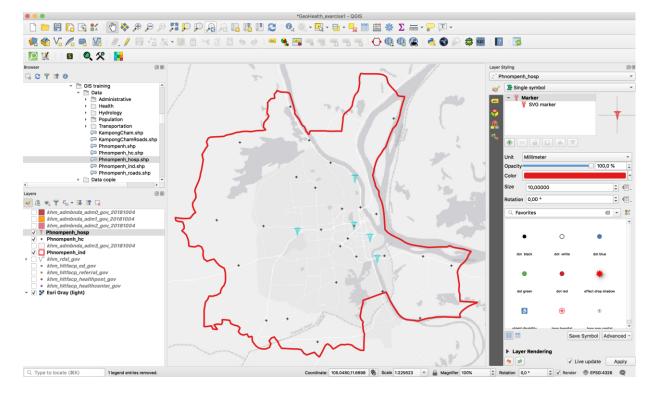
- Add the shapefiles of the referral hospitals and of the health centers to your map canvas and check their CRS (-> Indian 60 / UTM zone 48N)
- Add the shapefile of one province (here we take Phnom Penh) and check its CRS (-> WGS 84)
- Project this shapefile into the local projected CRS
- Go to the Vector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

.



Web

Vector Raster Database













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 ⁴, 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...

File name 2019-05-27-31-Formation Ecomore/GIS training/Data/Health/Hospitals_OSM_PhnomPenh.csv
Layer name Hospitals_OSM_PhnomPenh Encoding UTF-8
○ Regular expression delimiter
Custom delimiters
Record and Fields Options
Number of header lines to discard 0 🗘 🗸 V Decimal separator is comma
✓ First record has field names Trim fields
✓ Detect field types Discard empty fields
▼ Geometry Definition
Point coordinates X field Longitude
 Well known text (WKT) Y field Latitude
No geometry (attribute only table) DMS coordinates
Geometry CRS Project CRS: EPSG:4326 - WGS 84 🔹 🌚
▼ Layer Settings
Use spatial index Use subset index Watch file
Sample Data
name:km name:fr addr:city description healthcare healthcare:speciality Longitude Lat
1 104.924864 11.55 2 104.924948 11.55



lacksquare





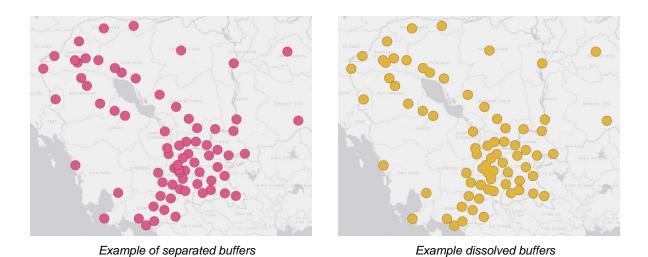
3.7. Creating buffer zones (buffers)

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

Parameters Log	Buffer
Input layer	 This algorithm computes a buffer area for all the features in an input layer, using a fixed or dynamic distance. The segments parameter controls the number of line segments to use to
 Open output file after running algorithm 	
0%	Cancel
Help Run as Batch Process	Close Run



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

	Distanc	ce Mat	trix	
Parameters Log Input point layer .* QGISfever [EPSG:3148]	•		9	Distance matrix This algorithm creates a table containing a distance matrix, with distances between all the points in a
Selected features only Input unique ID field				points layer.
123 id			*	
Target point layer				
** khm_hltfacp_referral_gov [EPSG:3148]	•		2	
Selected features only Target unique ID field				
123 PCODE			*	
Output matrix type				
Linear (N*k x 3) distance matrix			*	
Use only the nearest (k) target points				
0			4	
Distance matrix				
rmation Ecomore/GIS training/Data/Dist_Ho	sp_Cases	S.CSV		
✓ Open output file after running algorithm				
	0%	_	_	Cancel
Help Run as Batch Process				Close Run

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
 - o Run

	0410 10010	n Layor	oronn.						
Format	ESRI Shapefile	•							
File name	hm_admbnda_adm2	nm_admbnda_adm2_gov_20181004ind.shp 4							
Layer name									
CRS	EPSG:3148 - Indian	n 1960 /	UTM zone 48N	-					
Encoding		UTF-8							
Save only	selected features								
Select fi	elds to export and	their ex	port options						
▼ Geomet	ry .								
Geometry	type	Automa	atic	•					
-	nulti-type								
	z-dimension								
	z-aimension								
Extent (current: layer)									
🔻 Layer O	ptions								
RESIZE	10			•					
SHPT				-					
				•					
Help	✓ Add saved file to	o map	Cancel	OK					

Save Vector Laver as









Parameters Log Input layer khm_admbnda_adm2_gov_20181004ind [EPS6 Selected features only Overlay layer Phnompenh_ind [EPSG:3148] Selected features only Clipped 81-Formation Ecomore/GIS training/Data/Phnomper ✓ Open output file after running algorithm	• • • •	Clip This algorithm clips a vector layer usin the features of an additional polygon layer. Only the parts of the features in the Input layer that fall within the polygons of the Overlay layer will be added to the resulting layer. The attributes of the features are not modified, although properties such as area or length of the features will be modified by the clipping operation. If such properties are stored as attributes, those attributes will have to be manually updated.

- 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.

	Count Points in Polygon			
Parameters Log	4	Count poi	ints in po	lygon 🔒
Polygons Phnompenh_dist_ind [EPSG:3148] Selected features only	× ?	This algorithm and a polygon number of poin each polygons	layer and counts from the f	unts the first one in
Points * QGISfever [EPSG:3148] Selected features only Weight field [optional]	• Ø	A new polygor with the exact input polygons an additional f count correspond polygon.	same conten s layer, but co ield with the	nt as the ontaining points
Class field [optional]	• • • • • • • • • • • • • • • • • • •	An optional we to assign weig set, the count sum of the we contained by t	hts to each p generated wi ight field for o	oint. If ill be the
NUMPOINTS		Alternatively, a		
Count -27-31-Formation Ecomore/GIS training	/Data/Cases_districts.shp	be specified. In classified base attribute, and the same attrib	ed on the sele if several poin	ected nts with
	•	the polygon, o	bure funde un	
	0%			Cancel
Help Run as Batch Process			Close	Run

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



lacksquare



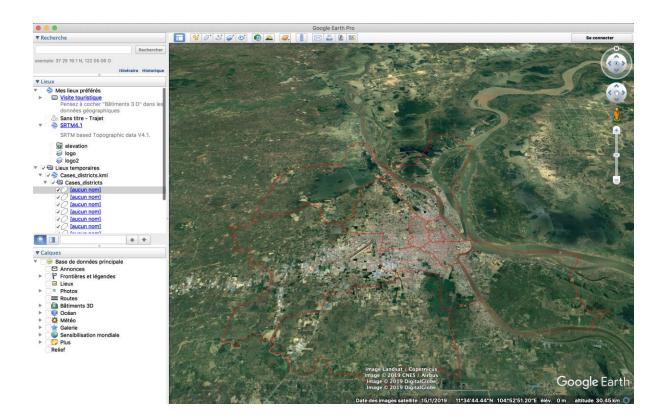


3.10. Exporting a layer to Google Earth

- 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.

	Save V	/ector Layer as						
Format	Keyhole Marku	ip Language [KML] 👻						
File name	ore/GIS traini	ng/Data/Cases_districts.kml 🛛 🛄						
Layer name	Layer name Cases_districts							
CRS	Project CRS: EPSG:4326 - WGS 84 🔹 🔹							
Select field	ds to export	and their export options						
Symbology ex	port	No symbology						
Scale		1:1000000 🗸 🔤						
Geometry								
Extent	(current: lay	er)						
Datasouro	e Options							
AltitudeMod	e relative	ToGround 👻						
DOCUMENT	_ID root_do	C						
Description	nField Description							
NameField	Name							
Custom O	ptions							
Help	Add saved f	ile to map Cancel OK						







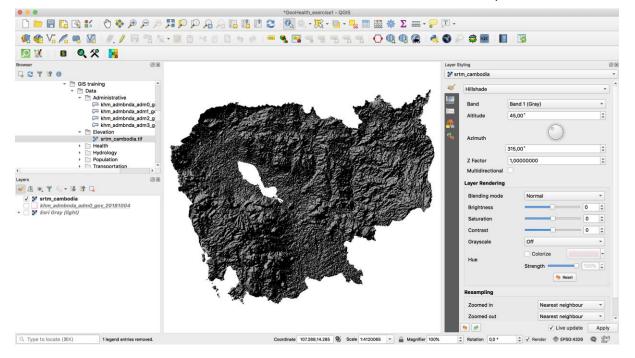


4. Using raster data

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 4, 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

	Clip Raster by Masi	k Layer	
Parameters	Log		
Input layer			A
F srtm_can	nbodia [EPSG:4326]		•
Mask layer			
Mondolk	iri [EPSG:4326]	.	
Selected 1	features only		
Source CRS	[optional]		
			- 🌚 _
Target CRS [optional]		
			-
Assign a spe	cified nodata value to output bands	[optional]	
Not set			*
Create an	output alpha band		
✓ Match the	extent of the clipped raster to the	extent of the mask laye	r –
	0%		Cancel
Help	Run as Batch Process	Close	Run









- 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.

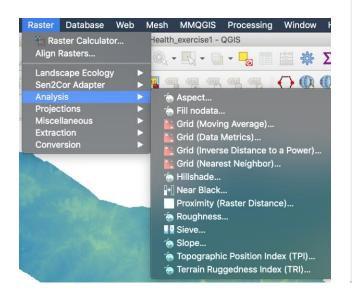
Exercise: Reproject the Mondlkiri DEM in the local projected CRS

- 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.

<pre>\$ srtm_Mondolkiri [EPSG:4326] \$ minimized in the second sec</pre>			Warp (Reproje	ect)	
 srtm_Mondolkiri [EPSG:4326] Source CRS [optional] Target CRS EPSG:3148 - Indian 1960 / UTM zone 48N Resampling method to use Nearest neighbour Nodata value for output bands [optional] Not set Output file resolution in target georeferenced units [optional] Not set Advanced parameters Reprojected Formation Ecomore/GIS training/Data/srtm_Mondolkiri_ind.tif Open output file after running algorithm 	Parameters	Log			
Source CRS [optional] Target CRS EPSG:3148 - Indian 1960 / UTM zone 48N Resampling method to use Nearest neighbour Nodata value for output bands [optional] Not set Not set Advanced parameters Reprojected Formation Ecomore/GIS training/Data/srtm_Mondolkiri_ind.tif Other output file after running algorithm O% Cancel	Input layer	U			4
Target CRS EPSG:3148 - Indian 1960 / UTM zone 48N Resampling method to use Nearest neighbour Nodata value for output bands [optional] Not set Output file resolution in target georeferenced units [optional] Not set Advanced parameters Reprojected Formation Ecomore/GIS training/Data/srtm_Mondolkiri_ind.tif Omega Om	srtm_Mc	ndolkiri [EPS0	G:4326]		•
EPSG:3148 - Indian 1960 / UTM zone 48N	Source CRS	[optional]			
EPSG:3148 - Indian 1960 / UTM zone 48N					-
Resampling method to use Nearest neighbour Nodata value for output bands [optional] Not set Output file resolution in target georeferenced units [optional] Not set Advanced parameters Reprojected Formation Ecomore/GIS training/Data/srtm_Mondolkiri_ind.tif Open output file after running algorithm	Target CRS				
Nearest neighbour Nodata value for output bands [optional] Not set Output file resolution in target georeferenced units [optional] Not set Advanced parameters Reprojected Formation Ecomore/GIS training/Data/srtm_Mondolkiri_ind.tif Image: Comparison of the output file after running algorithm	EPSG:3148	- Indian 1960	/ UTM zone 4	18N	-
Nodata value for output bands [optional] Not set Dutput file resolution in target georeferenced units [optional] Not set Advanced parameters Reprojected Formation Ecomore/GIS training/Data/srtm_Mondolkiri_ind.tif … Qopen output file after running algorithm Cancel	Resampling	method to use	Э		
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4.4. Deriving information from DEM: slopes, aspect, hillshading, contours

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



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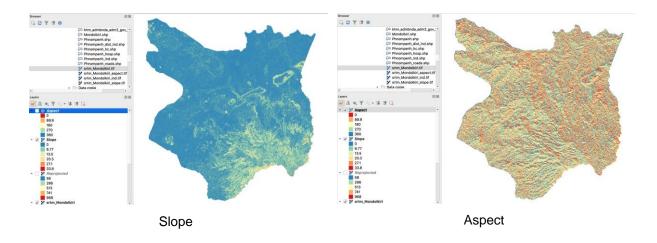




Exercise: Calculate slope and aspect in Mondolkiri province

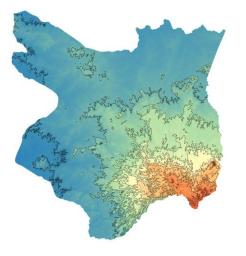
- Go to Raster Menu / Analysis / Slope...
- Choose the Mondolkiri DEM
- Browse to your folder and give a name to the raster of slopes
- Run
- The same applies to the calculation of exposure (aspect) and hillshading.

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



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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

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4.6. Downloading and using Sentinel-2 images

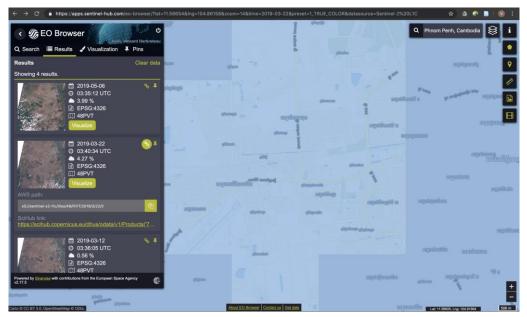
Browse and download Sentinel-2 images

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 险 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 Laver...
- 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

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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.

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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

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Raster Calculator





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 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.

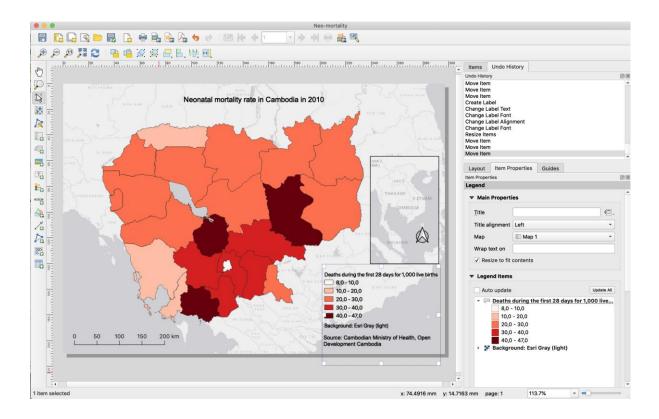
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- Add a legend:
 - o Go to "Add item" Menu / Add Legend
 - Place your legend on the map
 - When the legend is selected, you can adjust its properties in the Item Properties window
 - In the Legend items: uncheck "Auto update" to remove some parts of 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:
 - o 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.
 - o Go to "Add item" Menu / Add Label



- Export maps:
 - o 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

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