UNIVERSITÀ DEGLI STUDI DI PADOVA

GIS

Prof. Francesco Pirotti

The following handout gives instructions on how to access and download geospatial data from the web with different means:

1. Downloading data in your computer
2. Web Services WMS[1] / WFS / TMS
3. OpenStreetmap Data[2]

The objective is to be able to hunt for geospatial data for your future projects, including the project required for passing the exam.

1 Downloading geospatial data from web providers

An internet portal that provides several geospatial datasets for downloading is usually called a "Catalogue". Finding catalogues can be as easy as search using a search engine (e.g. Google), but sometimes require further investigation. In the next session some examples of web portals providing geospatial data with global, national and regional scales.

1.1 GLOBAL DATASETS

1.1.1 GEOSS portal: Group on Earth Observations

http://www.geoportal.org/   Geoportal allows to search for both downloads and W(FCM)S services (see "Online web mapping services WMS / WCS / WFS")
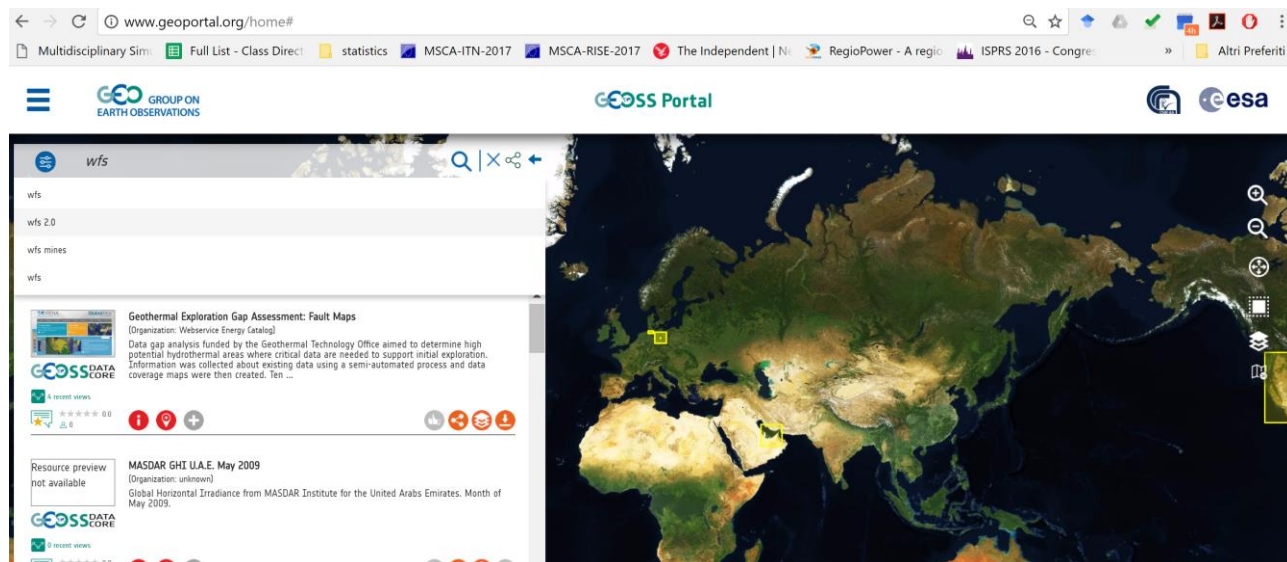
There are many options for filtering data.

---

[1] Check tutorial *Working with WMS Data*

[2] Check tutorial *Searching and Downloading OpenStreetMap Data*

## 1.1.2 USGS: EarthExplorer

USGS' EarthExplorer https://earthexplorer.usgs.gov/ provides raster data from satellite sensors. Special satellites (RADAR) allow to provide a raster of height values (DEM digital elevation model). In the following tutorial we will download a digital surface model (DSM) which differs from a digital terrain model (DTM) as the heights include buildings and trees, whereas the DTM only has heights of the bare terrain.

1. Create a user profile by registering from https://earthexplorer.usgs.gov/

Or directly from https://ers.cr.usgs.gov/register/
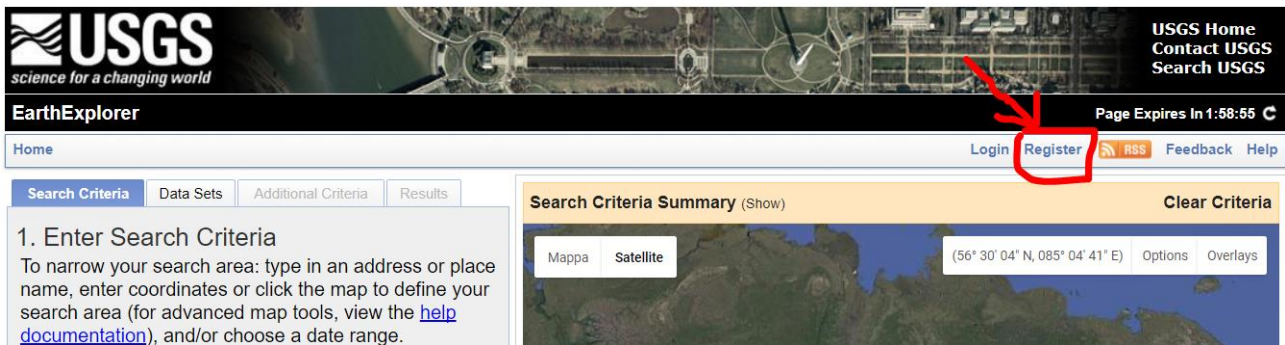
2. **Login** https://earthexplorer.usgs.gov/ with your registration credentials (username and password) by clicking "login" (see image above)
3. Identify your area in the map. There are several means:
   a. Search by address / place (e.g. Padova like the following image)
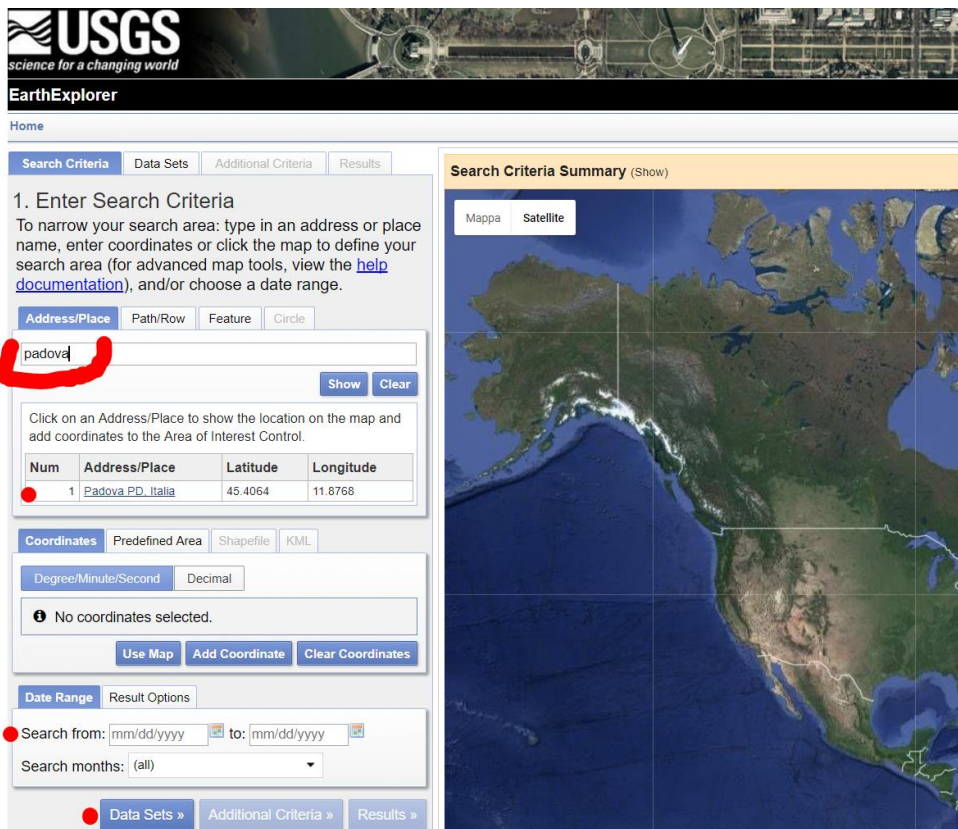
b. Click the map directly to create a polygon or a point defining your area of interest
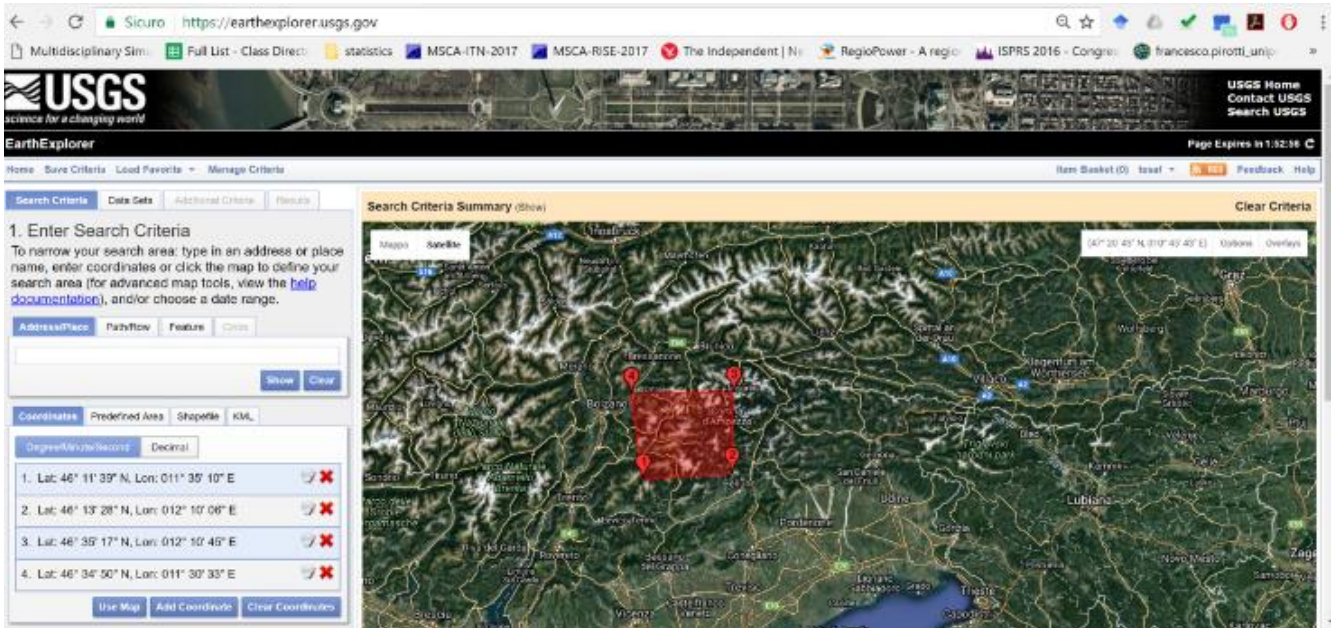
4. In the bottom, click on "datasets" (in some cases you can select a certain date – that's in case of multitemporal datasets)
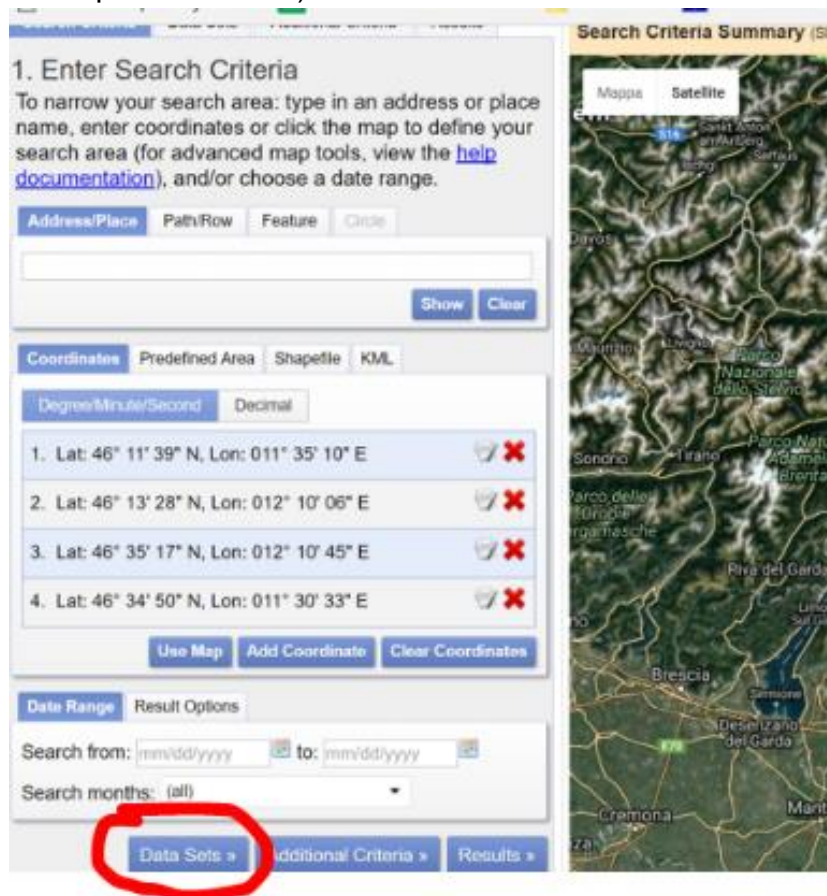
5. In the input space of "Data Sets Search" type "**SRTM**" – you will see the product that you can select by clicking the checkbox
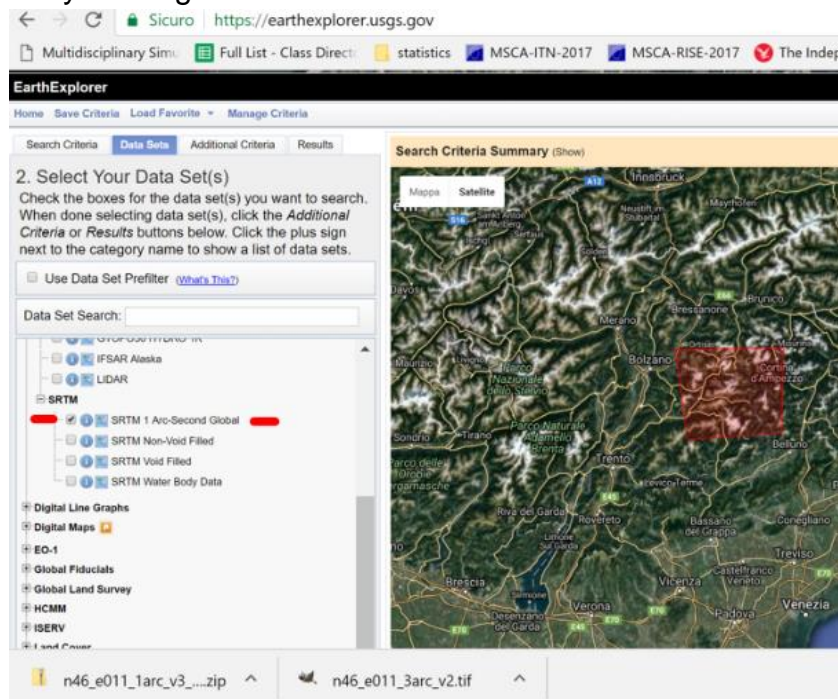
6. All SRTM products intersecting your area will appear – for each product you can select from the toolbar the following (from left to right – see image below)
   a. Show footprint
   b. Show preview on map
   c. Browse data
   d. Show metadata
   e. Download.
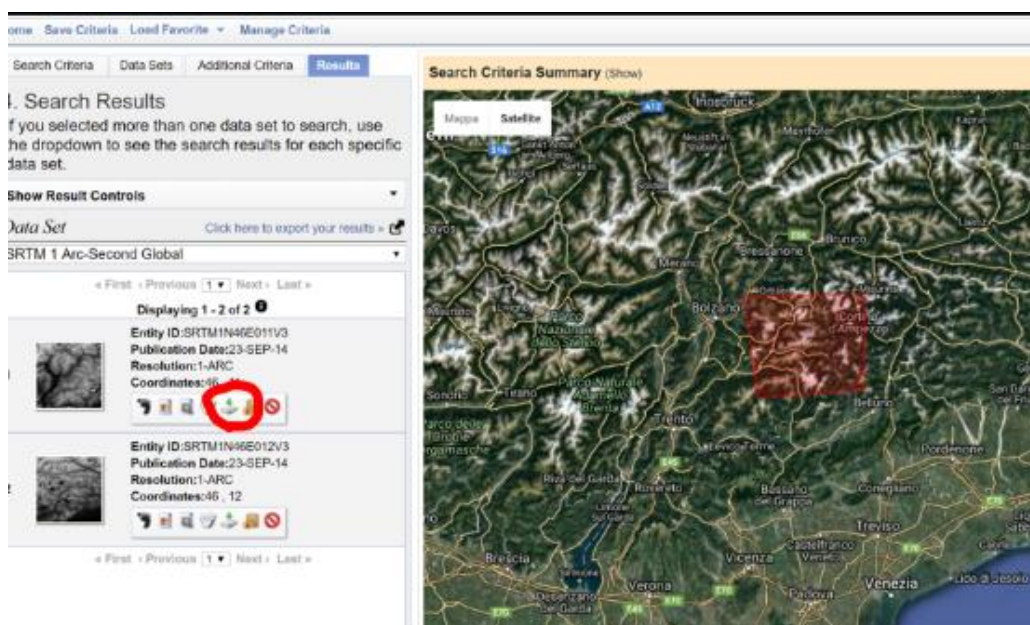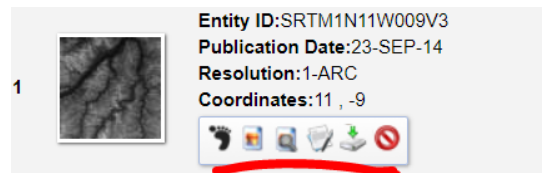
7. You can choose from three different raster formats, QGIS is able to read all of them (more on Raster Formats @ http://www.gdal.org/formats_list.html)
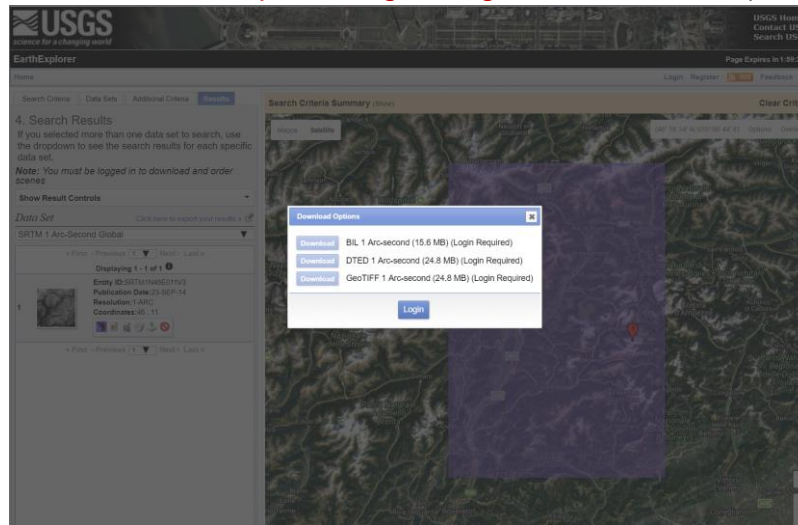
8. Load the file in your QGIS project –CRS of this file is 4326 (geographic latitude and longitude) – check handout on coordinate reference systems for more info in CRS.

Exercise: with the procedures above download "SRTM 1-arcsecond Global" and "ASTER Global DEM" datasets: **compare differences** in the two DEMs using the raster calculator and style the map. What are the minimum and maximum values?

1.1.3 FAO: GIS Dataset – GeoNetwork

http://www.fao.org/geonetwork/srv/en/main.home
Excellent source of global and agricultural and environmental data

Exercise: search for "rainfall African Water Resource Database" keywords and download rainfall data for Africa, e.g. "APRIL 1ST-DECADAL SHORT MEAN RAINFALL". This is Arc/Info Binary Grid (.adf) format (click link for more info). Style the map. NB: the CRS (coordinate reference system) of this map is not known.

1.1.4 United Nations: Geospatial Data - UNEP

http://geodata.grid.unep.ch/

Exercise: search for "climate africa" keywords and download rainfall data for Africa
You find both raster (BIL) and vector (ESRI Shapefile). Open the BIL file and style the map.

1.1.5   USGS: GIS Dataset – GLOBAL LANDCOVER collection

https://landcover.usgs.gov/ at link "Global Land Cover" (see image below) you will find a link to European Space Agency (ESA) datasets, see next section, **1.1.6 ESA: GlobCover**.

At link "30 meter Global Land Cover" also an interesting set of data for further GIS analyses (https://landcover.usgs.gov/glc/).

1.1.6 ESA: GlobCover

http://due.esrin.esa.int/page_globcover.php

Exercise: Styling exercise with ESA GlobCover

When you open with QGIS the GeoTIFF file, you only see numeric values of the single cells. Each cell value corresponds to a legend label. The label is found in the MS Excel file that is distributed with the dataset. In this exercise you will learn how to create a legend file to style the layer automatically.

Value	Label	Red	Green	Blue
11	Post-flooding or irrigated croplands (or aquatic)	170	240	240
14	Rainfed croplands	255	255	100
20	Mosaic cropland (50-70%) / vegetation (grassland/shrubland/forest) (20-50%)	220	240	100
30	Mosaic vegetation (grassland/shrubland/forest) (50-70%) / cropland (20-50%)	205	205	102
40	Closed to open (>15%) broadleaved evergreen or semi-deciduous forest (>5m)	0	100	0
50	Closed (>40%) broadleaved deciduous forest (>5m)	0	160	0
60	Open (15-40%) broadleaved deciduous forest/woodland (>5m)	170	200	0
70	Closed (>40%) needleleaved evergreen forest (>5m)	0	60	0
90	Open (15-40%) needleleaved deciduous or evergreen forest (>5m)	40	100	0
100	Closed to open (>15%) mixed broadleaved and needleleaved forest (>5m)	120	130	0
110	Mosaic forest or shrubland (50-70%) / grassland (20-50%)	140	160	0
120	Mosaic grassland (50-70%) / forest or shrubland (20-50%)	190	150	0
130	Closed to open (>15%) (broadleaved or needleleaved, evergreen or deciduous) shrubland (<5m)	150	100	0
140	Closed to open (>15%) herbaceous vegetation (grassland, savannas or lichens/mosses)	255	180	50
150	Sparse (<15%) vegetation	255	235	175
160	Closed to open (>15%) broadleaved forest regularly flooded (semi-permanently or temporarily) - Fresh or brackish water	0	120	90
170	Closed (>40%) broadleaved forest or shrubland permanently flooded - Saline or brackish water	0	150	120
180	Closed to open (>15%) grassland or woody vegetation on regularly flooded or waterlogged soil - Fresh, brackish or saline water	0	220	130
190	Artificial surfaces and associated areas (Urban areas >50%)	195	20	0
200	Bare areas	255	245	215
210	Water bodies	0	70	200
220	Permanent snow and ice	255	255	255
230	No data (burnt areas, clouds,...)	0	0	0

We can style the layer by right-click "Properties" and go the the "style" dialogue, but it would take a long time to enter all values by hand. Let's do a trick: save a dummy legend,

and then use a text editor to check format

```
dummy.txt
 1 # QGIS Generated Color Map Export File
 2 INTERPOLATION:EXACT
 3 19,221,169,57,255,random label
 4 66.8,187,94,65,255,66.8
 5 114,66,248,96,255,114
 6 162,169,59,92,255,162
 7 210,42,116,200,255,210
 8
```

Steps:

1. In MS Excel in the legend file information change columns to mirror the above table

Value	Red	Green	Blue	alpha	Label
11	170	240	240	255	Post-flooding or irrigated croplands (or aquatic)
14	255	255	100	255	Rainfed croplands
20	220	240	100	255	Mosaic cropland (50-70%) / vegetation (grassland/shrubland/forest) (20-50%)
30	205	205	102	255	Mosaic vegetation (grassland/shrubland/forest) (50-70%) / cropland (20-50%)
40	0	100	0	255	Closed to open (>15%) broadleaved evergreen or semi-deciduous forest (>5m)
50	0	160	0	255	Closed (>40%) broadleaved deciduous forest (>5m)
60	170	200	0	255	Open (15-40%) broadleaved deciduous forest/woodland (>5m)
70	0	60	0	255	Closed (>40%) needleleaved evergreen forest (>5m)
90	40	100	0	255	Open (15-40%) needleleaved deciduous or evergreen forest (>5m)
100	120	130	0	255	Closed to open (>15%) mixed broadleaved and needleleaved forest (>5m)
110	140	160	0	255	Mosaic forest or shrubland (50-70%) / grassland (20-50%)
120	190	150	0	255	Mosaic grassland (50-70%) / forest or shrubland (20-50%)
130	150	100	0	255	Closed to open (>15%) (broadleaved or needleleaved, evergreen or deciduous) shrubland (<5m)
140	255	180	50	255	Closed to open (>15%) herbaceous vegetation (grassland, savannas or lichens/mosses)
150	255	235	175	255	Sparse (<15%) vegetation
160	0	120	90	255	Closed to open (>15%) broadleaved forest regularly flooded (semi-permanently or temporarily) - Fresh or brackish water
170	0	150	120	255	Closed (>40%) broadleaved forest or shrubland permanently flooded - Saline or brackish water
180	0	220	130	255	Closed to open (>15%) grassland or woody vegetation on regularly flooded or waterlogged soil - Fresh, brackish or saline water
190	195	20	0	255	Artificial surfaces and associated areas (Urban areas >50%)
200	255	245	215	255	Bare areas
210	0	70	200	255	Water bodies
220	255	255	255	255	Permanent snow and ice
230	0	0	0	255	No data (burnt areas, clouds,...)

2. Select (as image above) and copy/paste to the text file



```
dummy.txt
 1 # QGIS Generated Color Map Export File
 2 INTERPOLATION:EXACT
 3 19,221,169,57,255,random label
 4 66.8,187,94,65,255,66.8
 5 114,66,248,96,255,114
 6 162,169,59,92,255,162
 7 210,42,116,200,255,210
 8
 9
10 11     170 240 240 255 Post-flooding or irrigated cropl
11 14     255 255 100 255 Rainfed croplands
12 20     220 240 100 255 Mosaic cropland (50-70%) / veget
13 30     205 205 102 255 Mosaic vegetation (grassland/shr
14 40     0   100 0   255 Closed to open (>15%) broadleave
15 50     0   160 0   255 Closed (>40%) broadleaved decidu
16 60     170 200 0   255 Open (15-40%) broadleaved decidu
17 70     0   60  0   255 Closed (>40%) needleleaved everg
18 90     40  100 0   255 Open (15-40%) needleleaved decid
19 100    120 130 0   255 Closed to open (>15%) mixed broa
20 110    140 160 0   255 Mosaic forest or shrubland (50-7
21 120    190 150 0   255 Mosaic grassland (50-70%) / fore
22 130    150 100 0   255 Closed to open (>15%) (broadleav
23 140    255 180 50  255 Closed to open (>15%) herbaceous
24 150    255 235 175 255 Sparse (<15%) vegetation
25 160    0   120 90  255 Closed to open (>15%) broadleave
26 170    0   150 120 255 Closed (>40%) broadleaved forest
27 180    0   220 130 255 Closed to open (>15%) grassland
28 190    195 20  0   255 Artificial surfaces and associat
29 200    255 245 215 255 Bare areas
30 210    0   70  200 255 Water bodies
31 220    255 255 255 255 Permanent snow and ice
32 230    0   0   0   255 No data (burnt areas, clouds,...)
```

3. Make sure to change column separators to correct ones (commas) – a "find and replace" should work on any text editor. The final result should be like the image below.

```
1   # QGIS Generated Color Map Export File
2   INTERPOLATION:EXACT
3   11,170,240,240,255,Post-flooding or irrigated croplands
4   14,255,255,100,255,Rainfed croplands
5   20,220,240,100,255,Mosaic cropland (50-70%) / vegetatic
6   30,205,205,102,255,Mosaic vegetation (grassland/shrubla
7   40,0,100,0,255,Closed to open (>15%) broadleaved evergr
8   50,0,160,0,255,Closed (>40%) broadleaved deciduous fore
9   60,170,200,0,255,Open (15-40%) broadleaved deciduous fc
10  70,0,60,0,255,Closed (>40%) needleleaved evergreen fore
11  90,40,100,0,255,Open (15-40%) needleleaved deciduous or
12  100,120,130,0,255,Closed to open (>15%) mixed broadleav
13  110,140,160,0,255,Mosaic forest or shrubland (50-70%) /
14  120,190,150,0,255,Mosaic grassland (50-70%) / forest or
15  130,150,100,0,255,Closed to open (>15%) (broadleaved or
16  140,255,180,50,255,Closed to open (>15%) herbaceous veg
17  150,255,235,175,255,Sparse (<15%) vegetation
18  160,0,120,90,255,Closed to open (>15%) broadleaved fore
19  170,0,150,120,255,Closed (>40%) broadleaved forest or s
20  180,0,220,130,255,Closed to open (>15%) grassland or wc
21  190,195,20,0,255,Artificial surfaces and associated are
22  200,255,245,215,255,Bare areas
23  210,0,70,200,255,Water bodies
24  220,255,255,255,255,Permanent snow and ice
25  230,0,0,0,255,No data (burnt areas, clouds,…)
26
```

4. Open the style dummy.txt that you modified
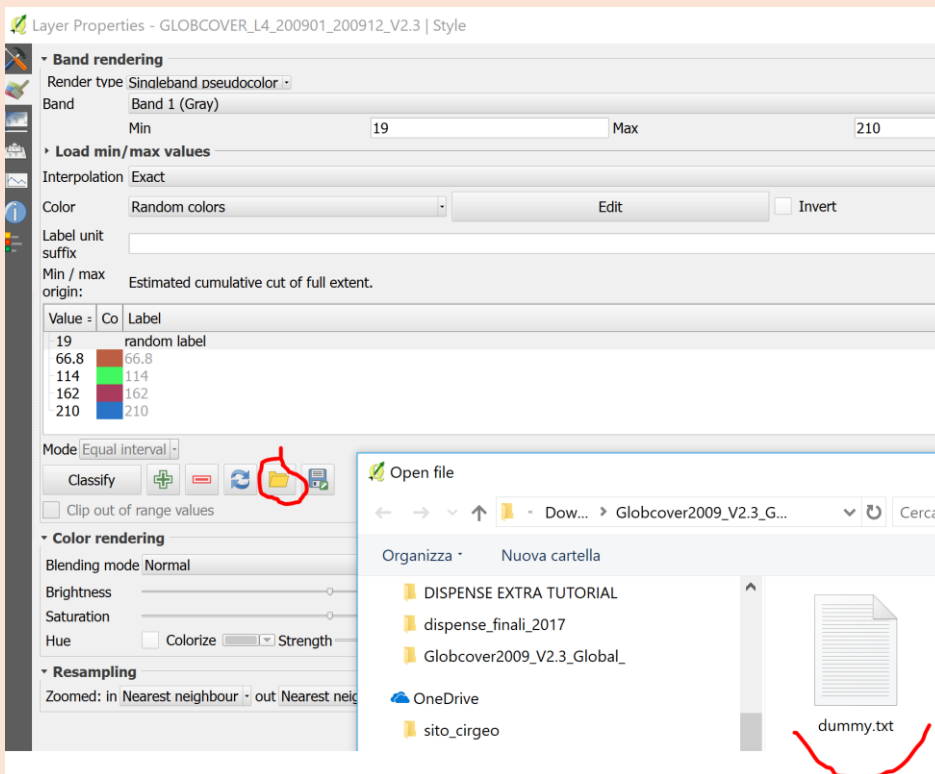
5. You will get a correct legend
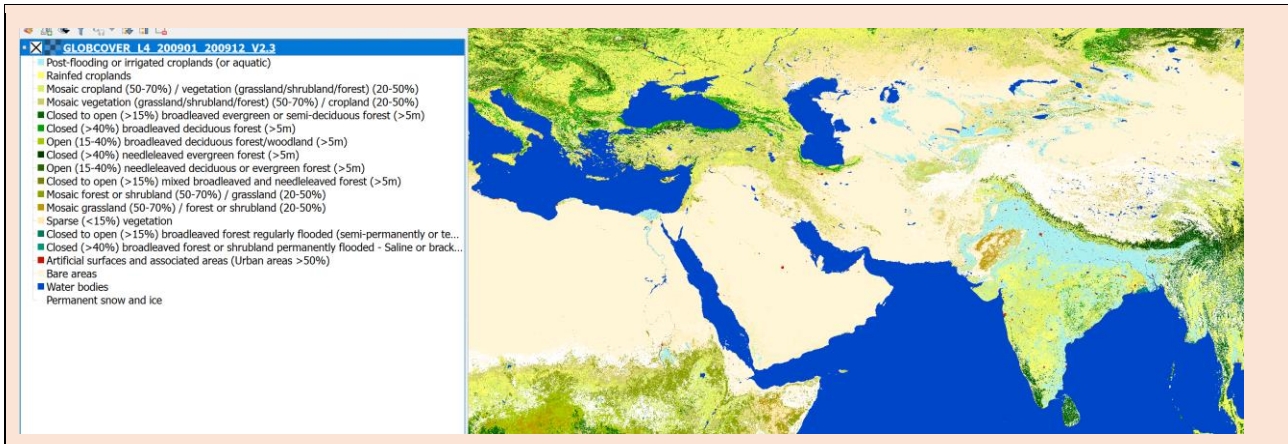
1.1.7 Got temperature/precipitation? UC Berkeley's WORLDCLIM rasters

WorldClim is a set of global climate layers (gridded climate data) with a spatial resolution of about 1 km^2. These data can be used for mapping and spatial modelling, and multi-criteria analysis (see the dedicated tutorial). http://worldclim.org

From the Google Earth Engine Catalogue description:

WorldClim V1 Bioclim provides bioclimatic variables that are derived from the monthly temperature and rainfall in order to generate more biologically meaningful values.

The bioclimatic variables represent annual trends (e.g., mean annual temperature, annual precipitation), seasonality (e.g., annual range in temperature and precipitation), and extreme or limiting environmental factors (e.g., temperature of the coldest and warmest month, and precipitation of the wet and dry quarters).

The bands scheme follows that of ANUCLIM, except that for temperature seasonality the standard deviation was used because a coefficient of variation does not make sense with temperatures between -1 and 1.

WorldClim version 1 was developed by Robert J. Hijmans, Susan Cameron, and Juan Parra, at the Museum of Vertebrate Zoology, University of California, Berkeley, in collaboration with Peter Jones and Andrew Jarvis (CIAT), and with Karen Richardson (Rainforest CRC).

Resolution
30 arc seconds (≈1 km)

Bands

Name	Units	Min	Max	Scale	Description
bio01	°C	-290*	320*	0.1	Annual mean temperature
bio02	°C	9*	214*	0.1	Mean diurnal range (mean of monthly (max temp - min temp))
bio03	%	7*	96*		Isothermality (bio02/bio07)
bio04	°C	62*	22721*	0.01	Temperature seasonality (Standard deviation * 100)
bio05	°C	-96*	490*	0.1	Max temperature of warmest month
bio06	°C	-573*	258*	0.1	Min temperature of coldest month

bio07	°C	53*	725*	0.1	Temperature annual range (bio05-bio06)
bio08	°C	-285*	378*	0.1	Mean temperature of wettest quarter
bio09	°C	-521*	366*	0.1	Mean temperature of driest quarter
bio10	°C	-143*	383*	0.1	Mean temperature of warmest quarter
bio11	°C	-521*	289*	0.1	Mean temperature of coldest quarter
bio12	mm	0*	11401*		Annual precipitation
bio13	mm	0*	2949*		Precipitation of wettest month
bio14	mm	0*	752*		Precipitation of driest month
bio15	Coefficient of Variation	0*	265*		Precipitation seasonality
bio16	mm	0*	8019*		Precipitation of wettest quarter
bio17	mm	0*	2495*		Precipitation of driest quarter
bio18	mm	0*	6090*		Precipitation of warmest quarter
bio19	mm	0*	5162*		Precipitation of coldest quarter
* estimated min or max value					

1.1.8 Google Earth Engine – great data provider but coding is required

Google Earth Engine is and advanced portal for processing satellite imagery and other geospatial big-data online through their map-reduce paradigm. You can put your hands on many datasets, process them and even download results or any intermediate data your produce – with limitations on the size of the data you can download. **Coding** is required (Javascript through their online https://code.earthengine.google.com/ or Python through Jupyter notebooks). Welcome to coding/programming if you want to dive deeper in more advanced GIS.

1.2 Regional datasets (Europe)

1.2.1 CORINE Land Cover

https://www.eea.europa.eu/publications/COR0-landcover

"*An inventory of land cover in 44 classes, and presented as a cartographic product, at a scale of 1:100 000. This database is operationally available for most areas of Europe.*"

You have 4 options for download

1. Raster (GeoTIFF) 100 m cell size
2. Raster (GeoTIFF) 250 m cell size
3. Vector model (ESRI Shapefile)
4. Vector model (SQLite Database).

http://land.copernicus.eu/pan-european/corine-land-cover

The current CLC 2012 version is v.18.5.1, which covers all EEA39 countries. For details click here.

Corine Land Cover products are available in both raster (100 and 250 meter resolution), and vector (ESRI and SQLite geodatabase). The Minimum Mapping Unit (MMU) for the CLC is 25 hectares for areal phenomena and 100 meter for linear phenomena. The time series (1990, 2000, 2006 and 2012) are complemented by change layers, which highlight changes in land cover with an MMU of 5 ha. If you are interested in changes between two surveys always use the CLC-Change layer, as this has a higher resolution than the status layer. Results can be filtered by using the search box.

*Please, remove **popup block** on your browser for http://land.copernicus.eu/ to download the products.*

Search: ☐

	Name	Year	Type	Format	Version	Size	Download
☐	Corine Land Cover	2012	Raster	● 100m GeoTIFF	18.5.1	71.4 MB	⤓
☐	Corine Land Cover	2012	Raster	● 250m GeoTIFF	18.5.1	31.8 MB	⤓
☐	Corine Land Cover	2012	Vector	● ESRI Geodatabase	18.5.1	1.8 GB	⤓
☐	Corine Land Cover	2012	Vector	● SQLite Database		2.5 GB	⤓

Download selected items (0)   Download all

1.3   Regional datasets (Italy)

1.3.1   Lombardy Region cartographic portal

http://www.geoportale.regione.lombardia.it/download-dati

1.3.2   Veneto Region cartographic portal

The Veneto Region portal - https://idt2.regione.veneto.it - provides downloading capabilities and also services (see chapter **Online web mapping services WMS / WCS / WFS**).

For downloading raster and vector datasets:

https://idt2.regione.veneto.it/idt/downloader/download

You can choose the CRS (see the handout on coordinate reference systems), and filter using the province and municipality of interest (e.g. Padova) – below and example for downloading the Urban Agricultural Areas.

If you want to mine for data using key-words, you can use the Catalog

With key-words you can find both geospatial data and documents. If you want only geospatial data you can filter using only "Layers"

From results you can:

1- Read metadata. Metadata keep all information that are not directly in the data – for example who is the owner, the date that data were acquired, copyright etc…

2- You can download the layer for all the Region or for only a municipality or province.

3- Almost all data are available also via web services, check Online web mapping services WMS / WCS / WFS section below.

2 Online web mapping services WMS / WCS / WFS

These are online services providing access to the data for download or visualization. WMS is only for visualization, WCS and WFS are respectively for downloading data as well, for raster (grid) data and vector data respectively.

1. WMS – Web Mapping Services – see also tutorial
2. WCS – Web Coverage Services
3. WFS – Web Feature Services

There are many more services, which are standards defined by user community of the Open Geospatial Consortium (https://en.wikipedia.org/wiki/Open_Geospatial_Consortium) - OGC. As a matter of fact these services have been recently referred to the term: **OWS** – **O**pen Geospatial Consortium (OGC) **W**eb **S**ervices.

You access these data either from the menu bar, "Layer"➔"Add layer"
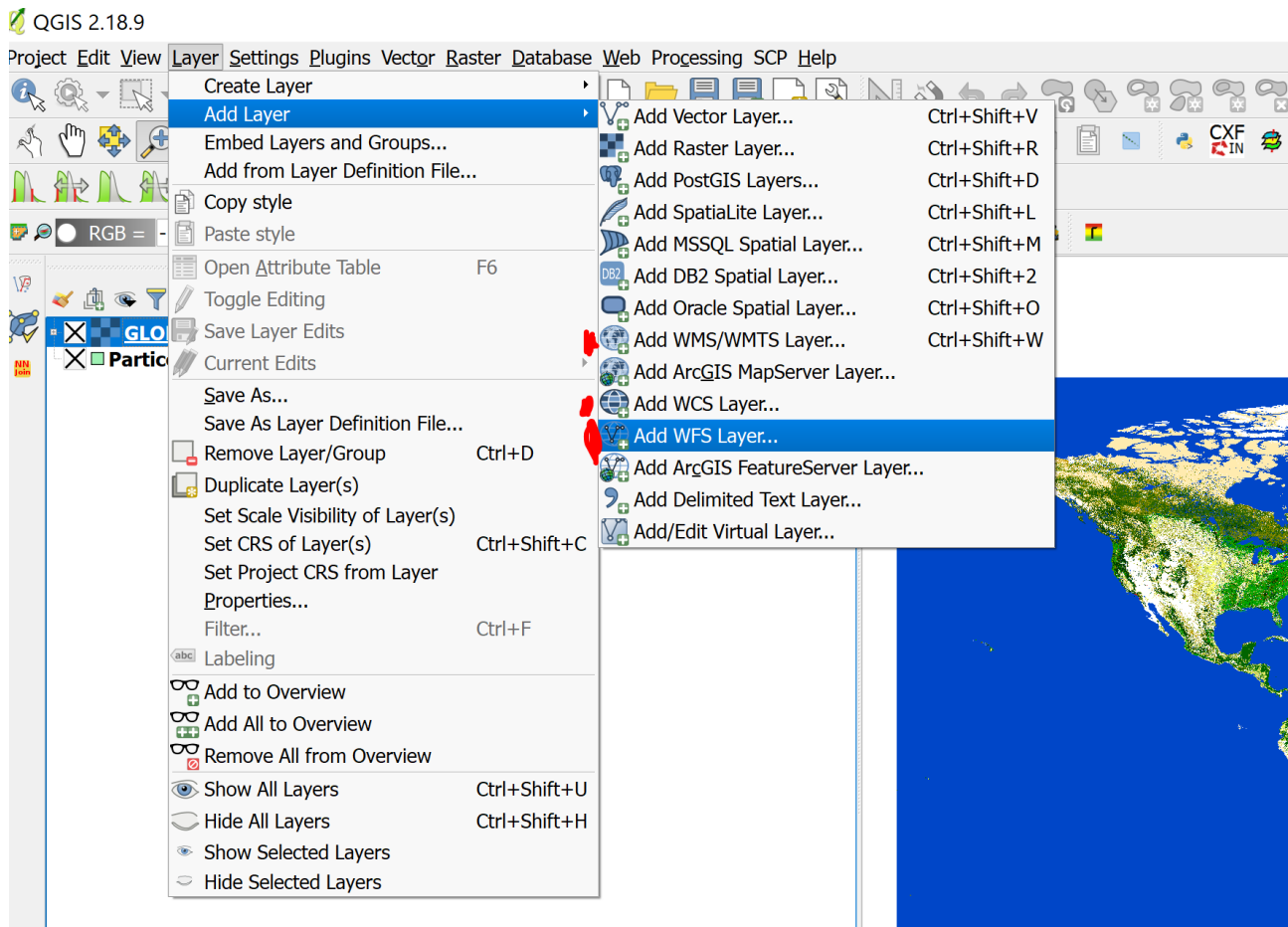
…or you can use the Data source manager by clicking the icon in the toolbar (see figure below).
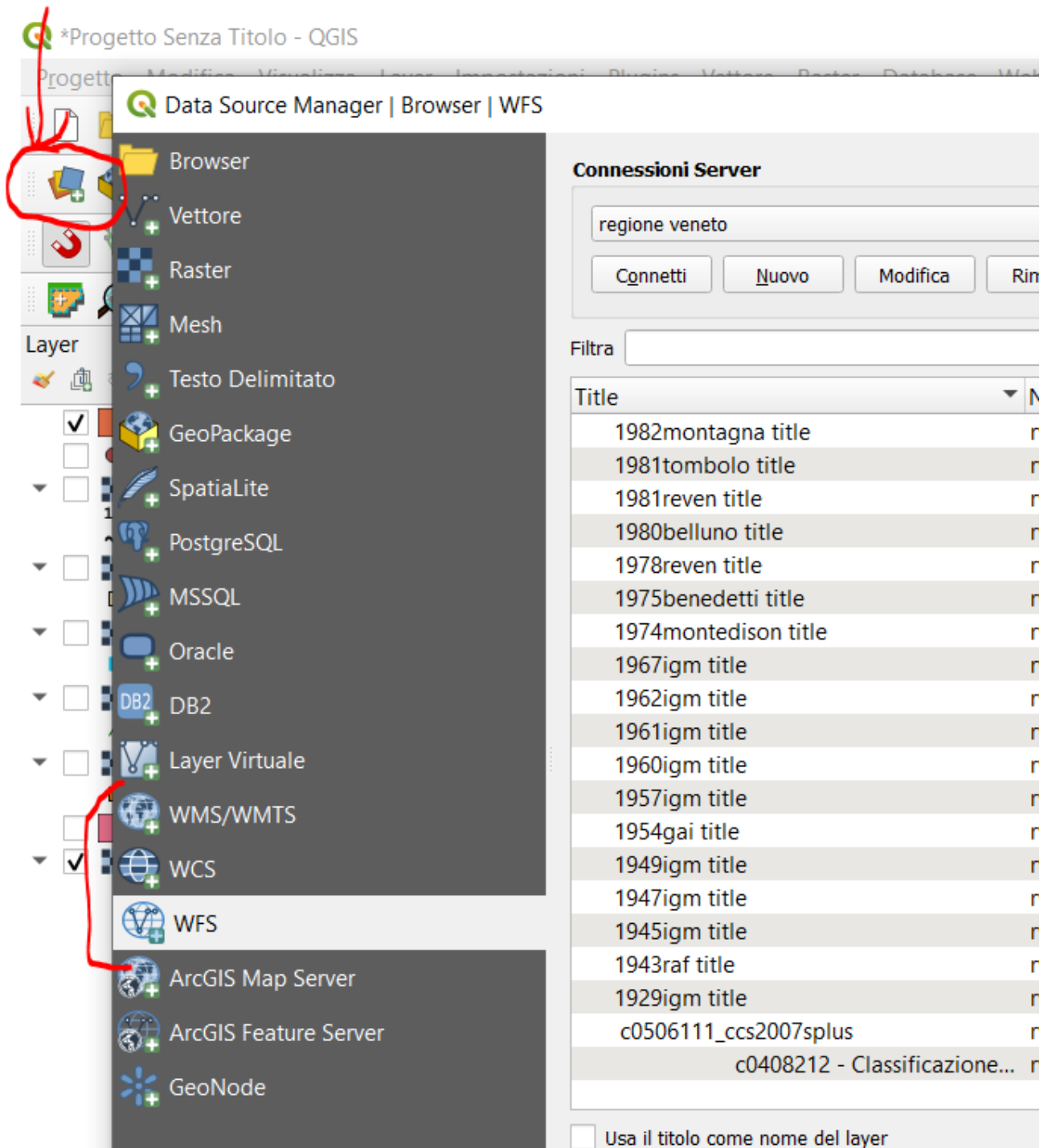
In all cases you will need to add a web address (URL) to the dialogue window. See next example and bottom of next section for some URL sources.

2.1.1 National Geo Portal – WFS services

http://www.pcn.minambiente.it/mattm/en/

Click "Services➔ "Network Services - OGC".


Select in the next page WFS Services

You will see a list of datasets, all have a URL address – we will "Copy URL" of the data we want. For example "Unità amministrative" is the border of municipalities in Italy (layer names are only in Italian).
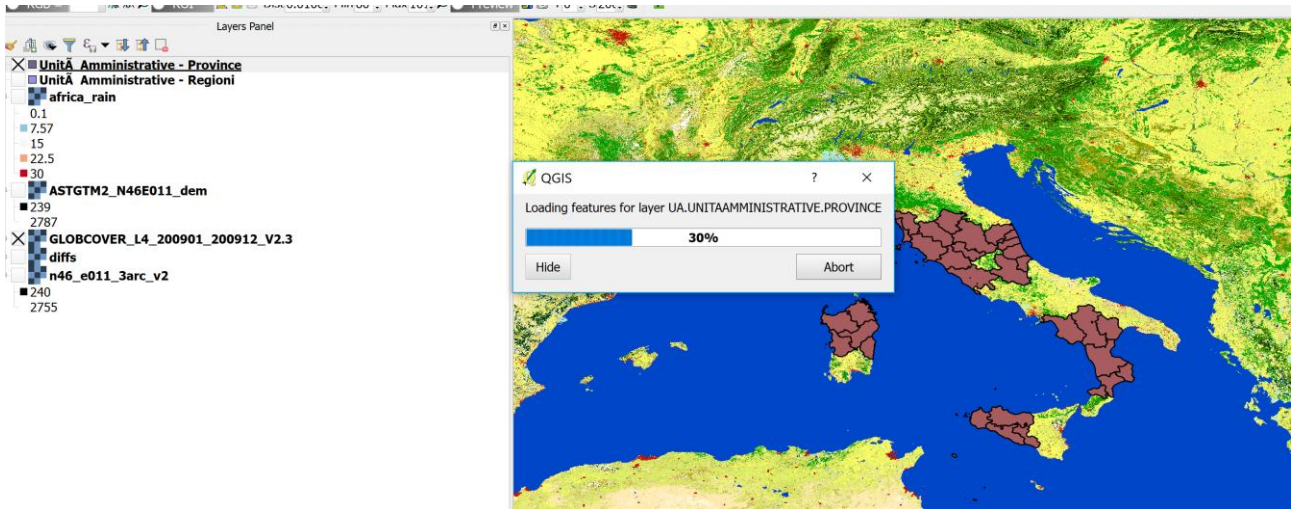

In the QGIS menu "Layer"➔"Add Layer"➔"Add WFS layer" you will get a dialogue window, click "New" and copy the URL in the input area, and give a Name to the layer
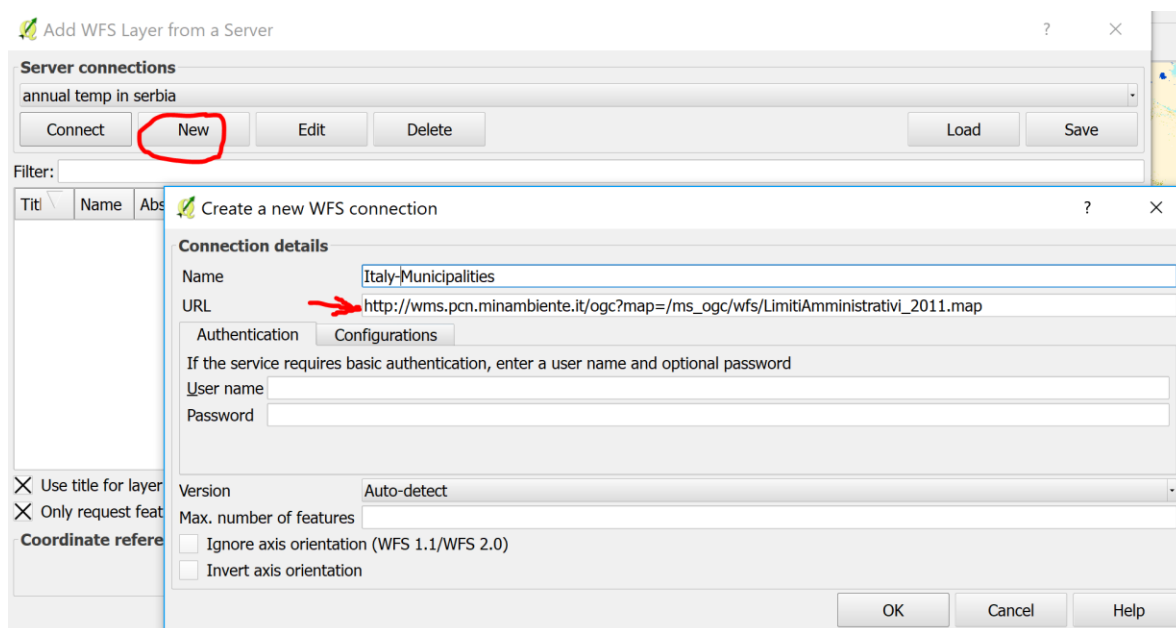
After click "ok" and "connect" from the main window. You will get three sub-layers: regions, provinces and towns – you can choose one ore more layers and then "Add" to add to project:
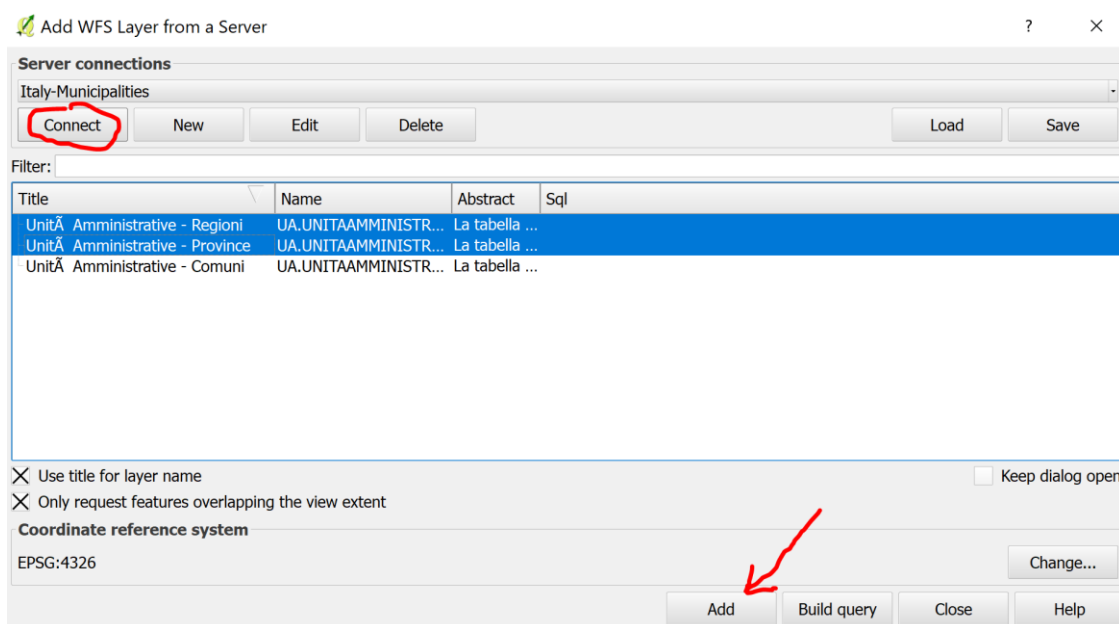
The layers will load: it might take some time depending on the size of the data, on internet connection speed and on the speed of the server providing the WFS service

NB: the same identical procedure can be used to add WMS or WCS service layers, which add raster data: QGIS menu "Layer"➔"Add Layer"➔"Add WCS layer" or "Add WMS layer"

2.1.2   Other OGC OWS services

https://www.qgistutorials.com/en/docs/working_with_wms.html

WMS

https://mrdata.usgs.gov/wms.html - USGS OGC Web Mapping Services

https://idt2-geoserver.regione.veneto.it/geoserver/ows - Veneto Region Styled raster

https://idt2.regione.veneto.it/gwc/service/wmts - Veneto Region orthophotos

WFS

https://mrdata.usgs.gov/wfs.html - USGS OGC Web Feature Services

https://idt2-geoserver.regione.veneto.it/geoserver/ows - Veneto Region

## 2.2   TMS services – Google – Bing – OpenStreetmap etc…

TMS Services are a particular type of online services that provide visual maps, usually styled maps and aerial imagery (e.g. Google Maps). They are very fast to load and are used as base maps to view study area extents and provide visual information of your area.

QGIS provides two plugins to access TMS data, OpenLayers and QuickMapServices. We will use "QuickMapServices" as it is more robust. The procedure to install the plugin is the following:

1. Download the plugin "QuickMapServices"   (menu "Plugins"➜"Manage and install plugins"). NB is you do NOT see a large list of plugins, you might not be connected to the internet or maybe QGIS has trouble connecting – to solve (i) check that internet is working (ii) close and reopen the Plugin panel window (iii) if still no plugins, restart QGIS.
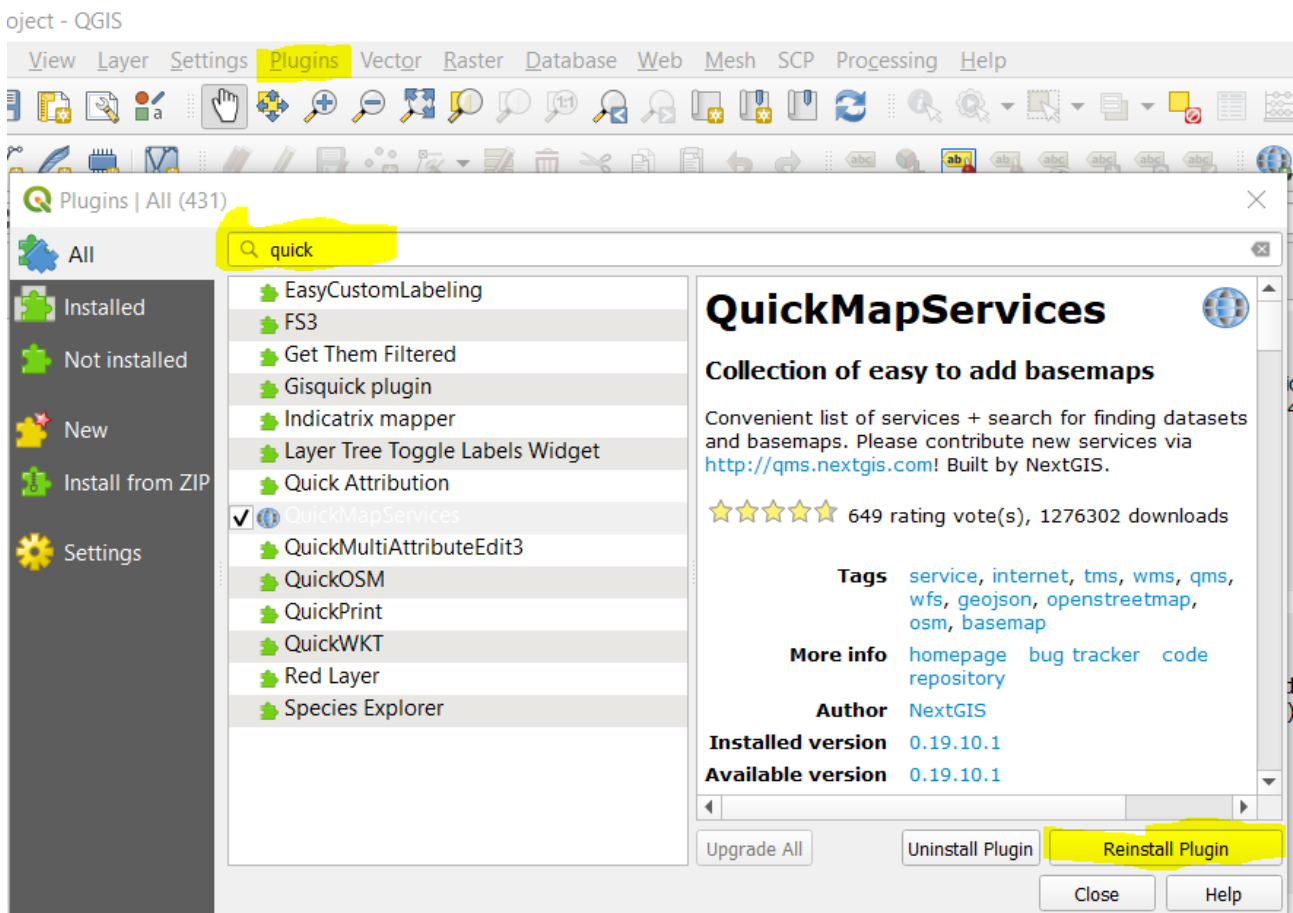

2. Once installed, you will see the plugin in the menu at "Web"➜ "QuickMapServices" – you will see many available map services that can be loaded, **but not all**

3. to load all services go to menu "Web"➜"QuickMapServices"➜"Settings": from dialogue window click "More Services" ➜"Get Contributed Pack"
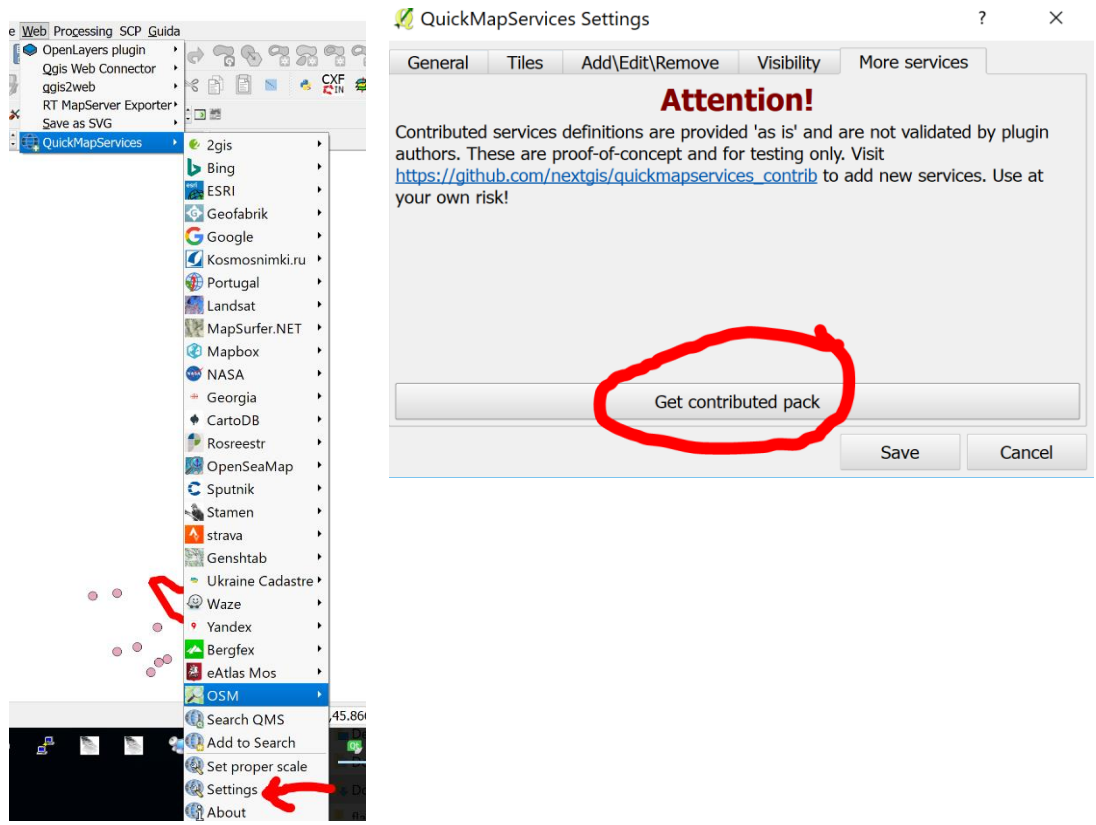
4. Now from menu "Web"➔ "QuickMapServices" you will see all available services: select "Google"➔"Google Satellite" you will have access to Google image database up to a resolution below 1 m in almost all of the Earth surface!!
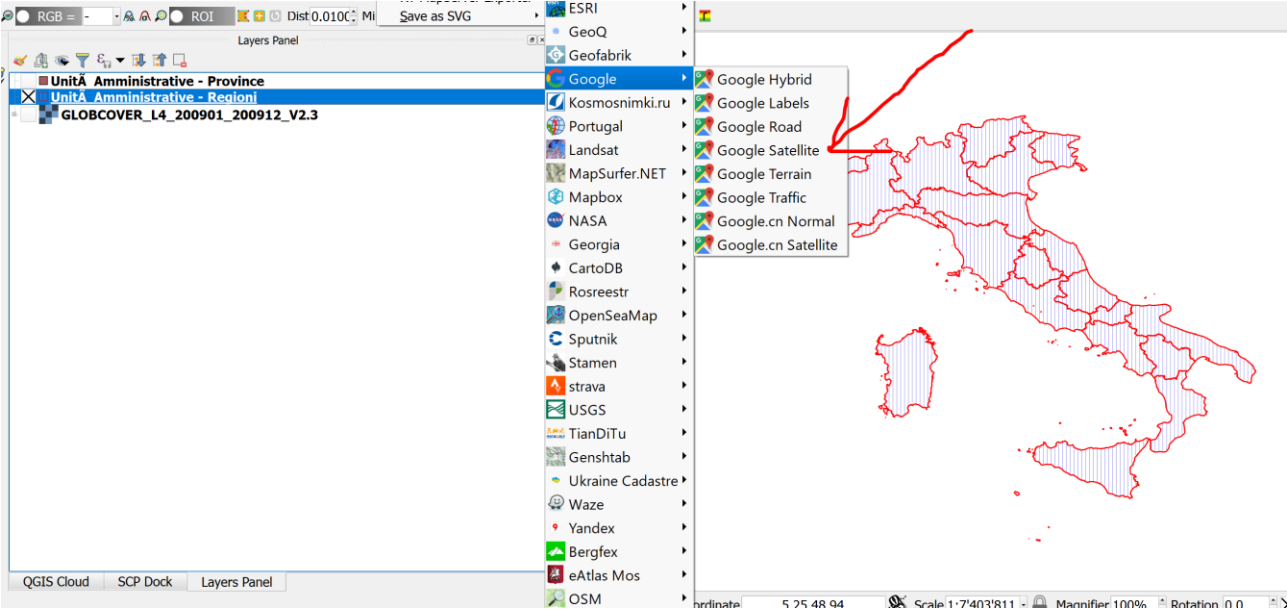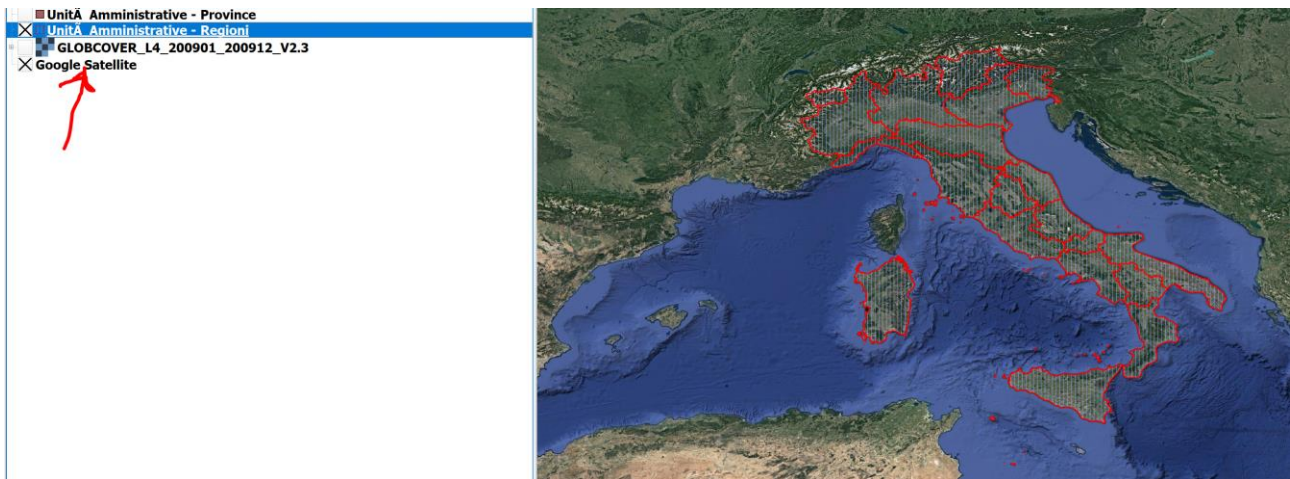
2.3   Open Streetmap

Open StreetMap is a special type of service providing access to their data also for download. Check online tutorial Searching and Downloading OpenStreetMap Data