

1. General concepts

WoSIS - World Soil Information Service.

Database to safeguard Soil data (point, polygon and raster) and distribute standardized soil data.

WFS - Web Feature Service, OGC (Open Geospatial Consortium) standard, allows request for geographical (vectorial) features across the web, server – client (desktop or web application).

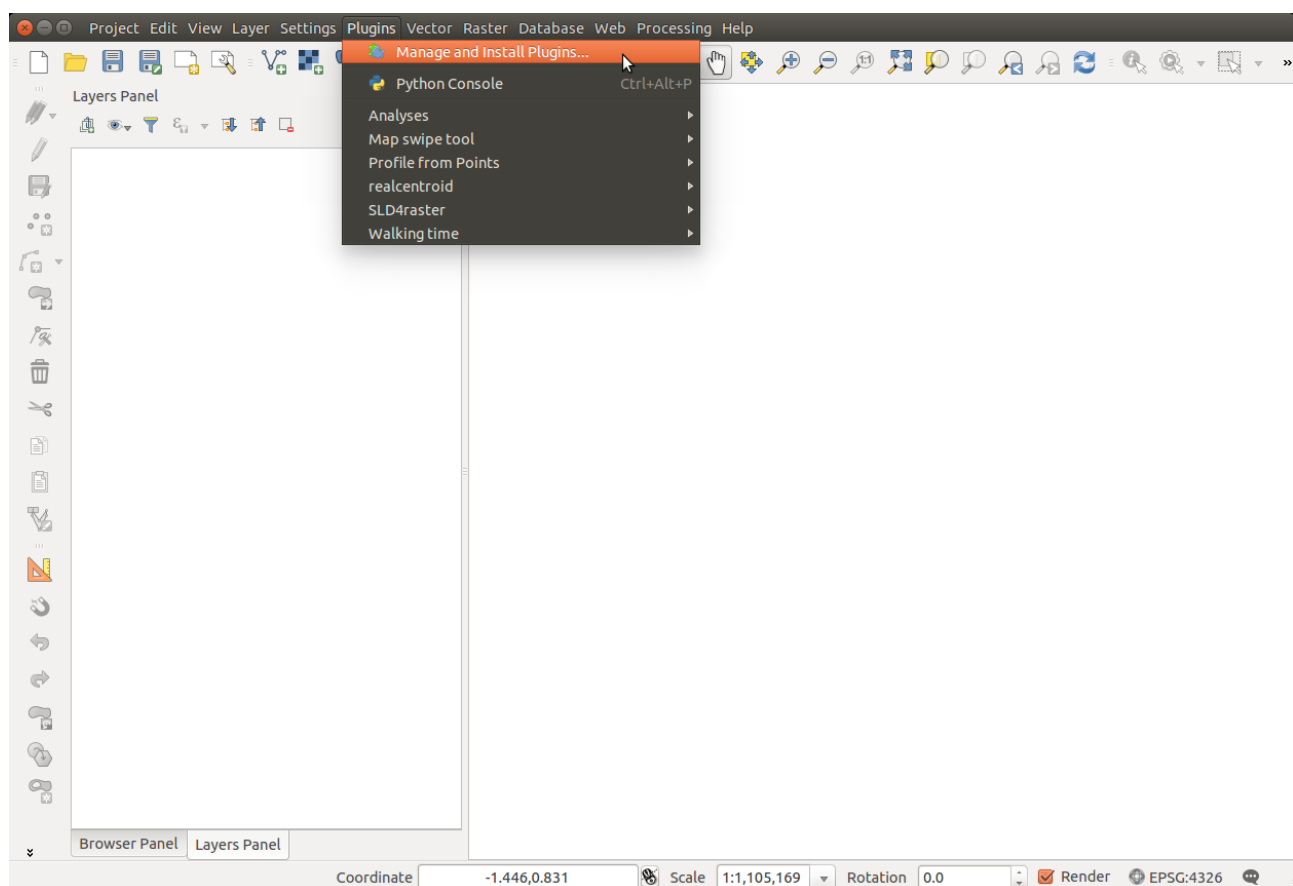
WCS - Web Coverage Service. Allows request for raster (grid data) across the web.

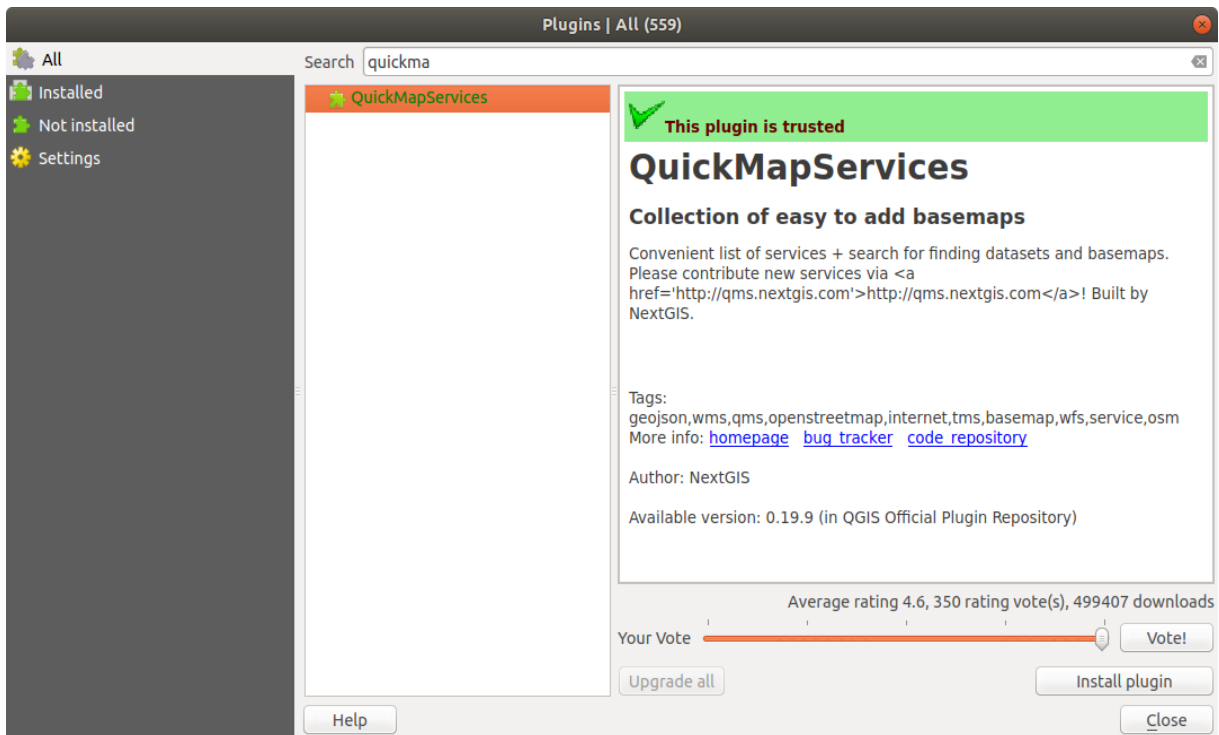
WMS - Web Map Service. Allows request for tiles (like Google map does) across the web.

2. Set up a base layer

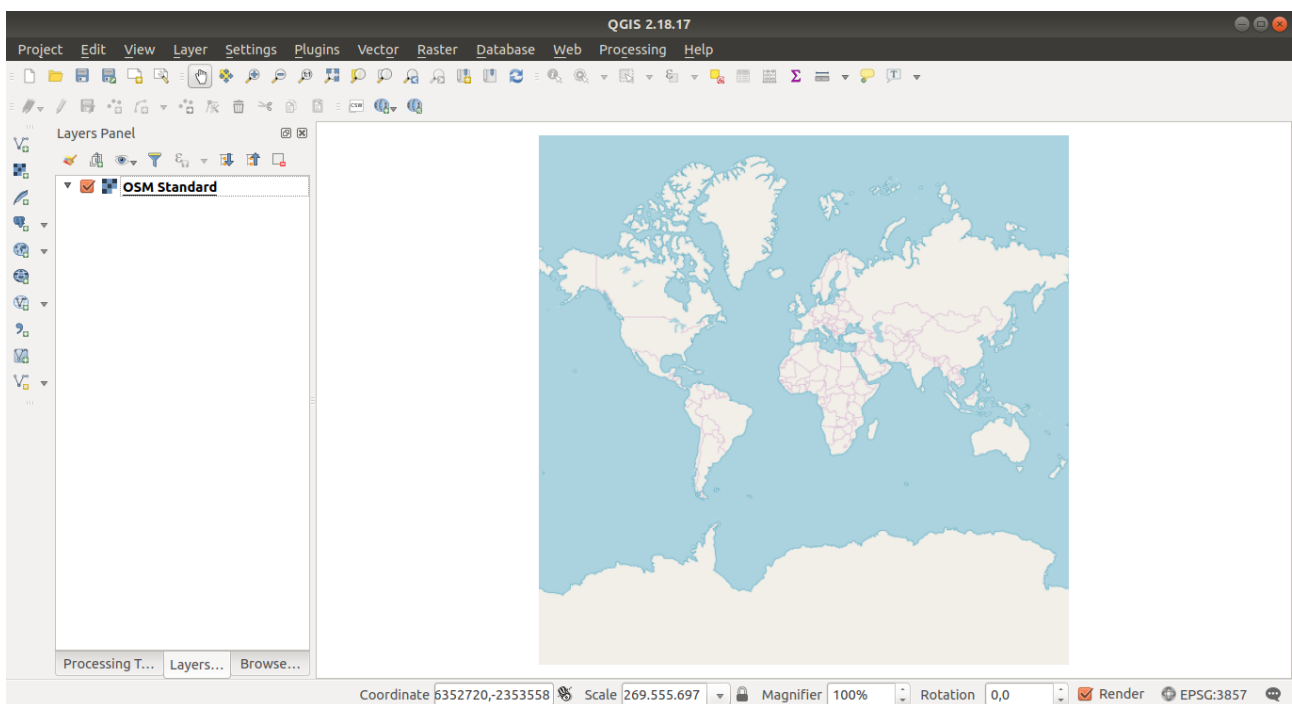
For that we need to install the 'QuickMapServices' plugin.

Go to '**Plugins**' → '**Manage and Install Plugins...**' → Type '**QuickMapServices**' in the search box → Select it and hit '**Install plugin**'. 'Point sampling tool' and 'Value tool' are other interesting plugins.



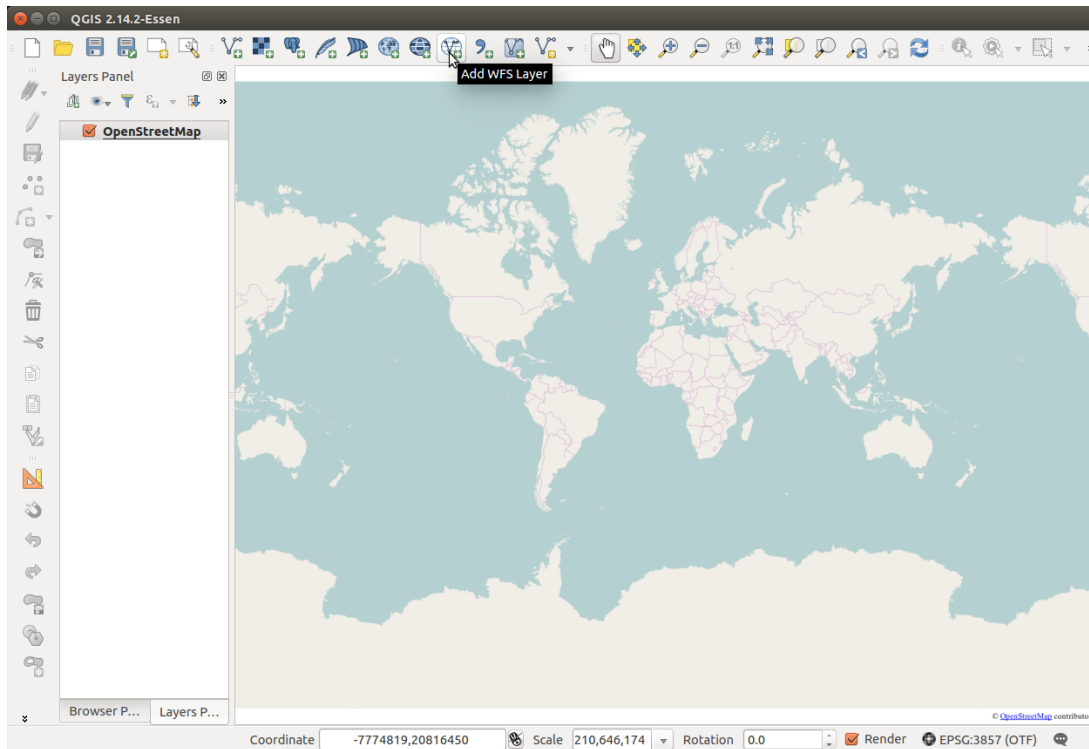


Load the base layer by going to 'Web' → 'QuickMapServices' and choose one of the base maps available. We will use **OSM Satandard**. In order to see all continents select the layer on the left (**OSM Satandard**) and right click on it and choose first option, 'Zoom to Layer'.

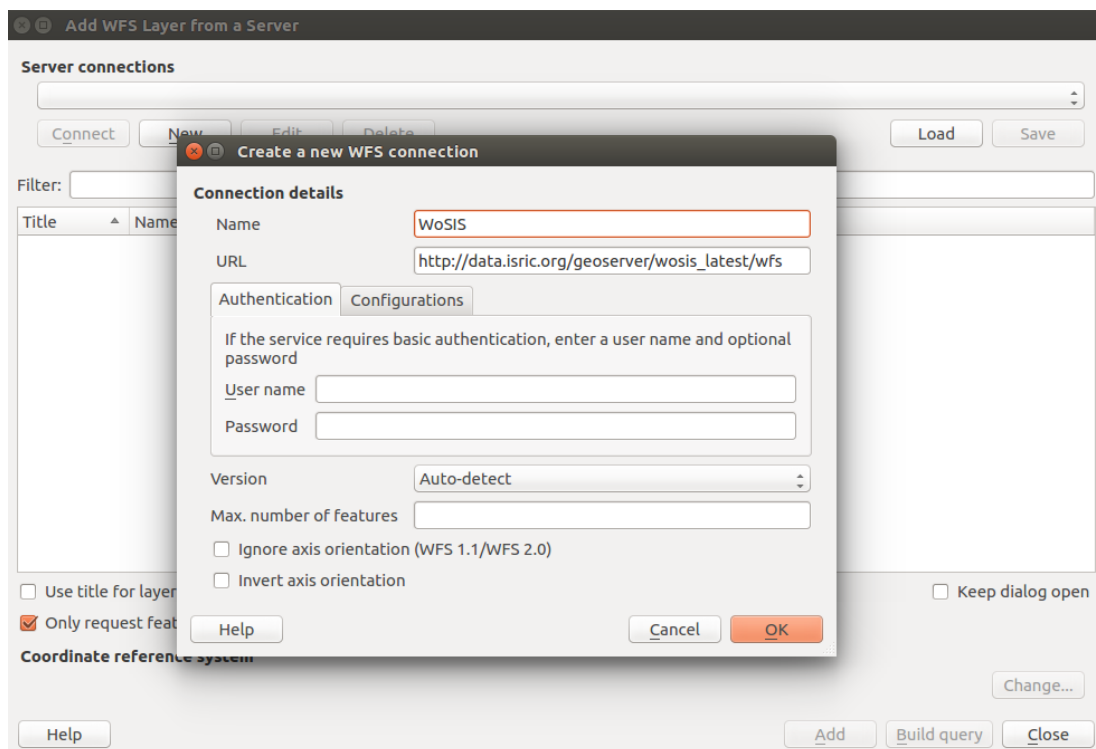


3. Accessing WoSIS from QGIS using WFS

To open and view WoSIS Soil profile data in QGIS, you first need to create a WFS connection. To do this press '**Layer**' → '**Add Layer**' → '**Add WFS layer...**' (There is also a direct button).



Then press '**New**', under **name**, you can put the name you want, for example, '**WoSIS**' and in the **URL** field put **http://data.isric.org/geoserver/wosis_latest/wfs/** . No authentication is needed here, so leave blank the '**User name**' and '**Password**' boxes. Press the **OK** button.



Press **‘Connect’** and all available layers will appear on screen.

Next, **select the layer** of interest listed under ‘Title’ and press **‘Add’** button. Note that it may take some time until you fetch all points for the global coverage. Be aware that you are working online and that some layers have over half a million records. So probably a more efficient approach would be to request only the points for a specific area. In this case, first zoom to the area of interest and then make sure that **‘Only request features overlapping the current view extent’** is ticked when you are adding the WFS layer.

Add WFS Layer from a Server

Server connections: WoSIS

Buttons: Connect, New, Edit, Delete, Load, Save

Filter:

Title	Name	Abstract	Sql
Bulk density fine earth - 33 kPa (kg/dm³)	wosis_latest:wosis_latest_bdfi33	Bulk density of the...	
Bulk density fine earth - air dry (kg/dm³)	wosis_latest:wosis_latest_bdfiad	Bulk density of the...	
Bulk density fine earth - field moist (kg/dm³)	wosis_latest:wosis_latest_bdfifm	Bulk density of the...	
Bulk density fine earth - moisture condition not speci...	wosis_latest:wosis_latest_bdfins	Bulk density of the...	
Bulk density fine earth - oven dry (kg/dm³)	wosis_latest:wosis_latest_bdfiod	Bulk density of the...	
Bulk density whole soil - 33 kPa (kg/dm³)	wosis_latest:wosis_latest_bdws33	Bulk density of the...	
Bulk density whole soil - moisture condition not spec...	wosis_latest:wosis_latest_bdwsns	Bulk density of the...	
Bulk density whole soil - oven dry (kg/dm³)	wosis_latest:wosis_latest_bdwsod	Bulk density of the...	
Calcium carbonate equivalent total (g/kg)	wosis_latest:wosis_latest_tceq	The content of car...	
Cation exchange capacity - buffer not specified (cmo...	wosis_latest:wosis_latest_cecnsp	Capacity of the fin...	
Cation exchange capacity - buffered at pH7 (cmol(c)/...	wosis_latest:wosis_latest_cecph7	Capacity of the fin...	
Cation exchange capacity - buffered at pH8 (cmol(c)/...	wosis_latest:wosis_latest_cecph8	Capacity of the fin...	
Clay total (g/100g)	wosis_latest:wosis_latest_clay	Gravimetric conte...	
Coarse fragments gravimetric total (g/100g)	wosis_latest:wosis_latest_cfgr	Gravimetric conte...	
Coarse fragments volumetric total (cm³/100cm³)	wosis_latest:wosis_latest_cfvo	Volumetric conten...	
Effective cation exchange capacity (cmol(c)/kg)	wosis_latest:wosis_latest_ecec	Capacity of the fin...	
Electrical conductivity - ratio 1:x (dS/m)	wosis_latest:wosis_latest_elco1x	Ability of a 1:x soil ...	
Electrical conductivity - ratio not specified (dS/m)	wosis_latest:wosis_latest_elcons	Ability of a not spe...	
Electrical conductivity - saturated paste (dS/m)	wosis_latest:wosis_latest_elcosp	Ability of a saturat...	
Organic carbon (g/kg)	wosis_latest:wosis_latest_orgc	Gravimetric conte...	

☐ Use title for layer name ☐ Keep dialog open

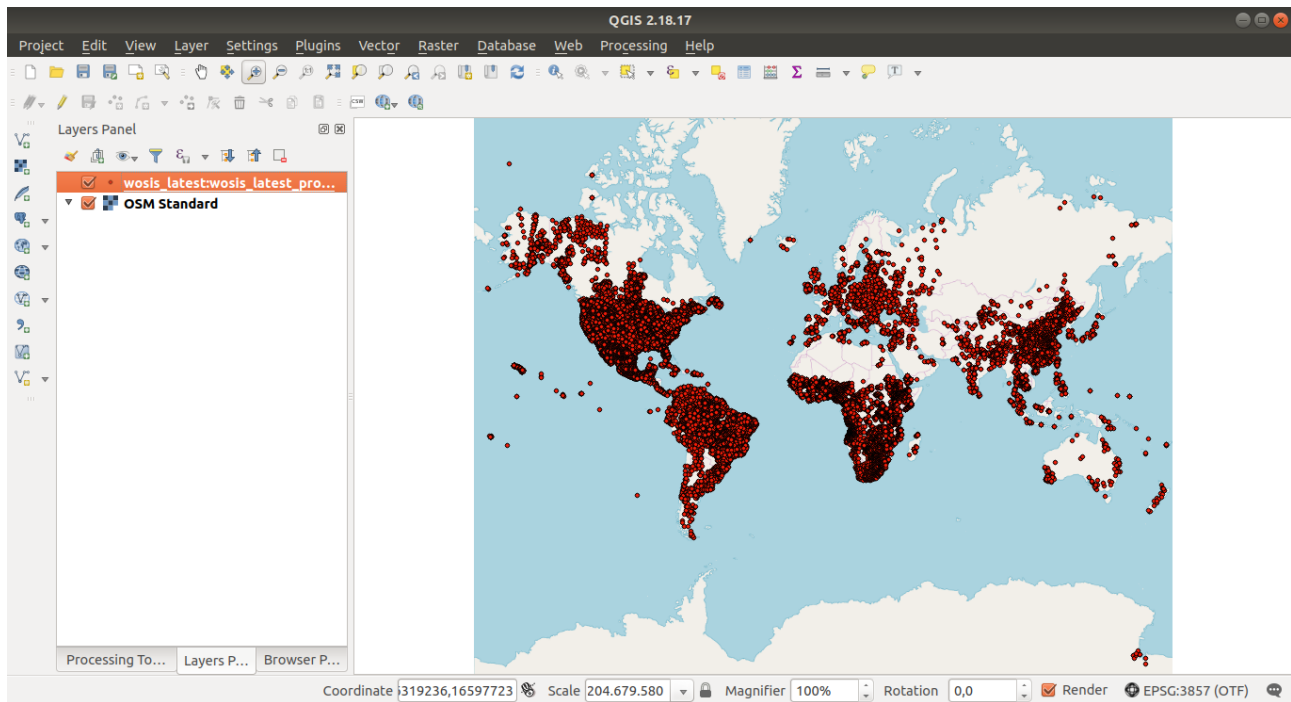
☒ Only request features overlapping the view extent

Coordinate reference system: EPSG:4326 Change...

Buttons: Help, Add, Build query, Close

3.1. Check all the available profiles sites

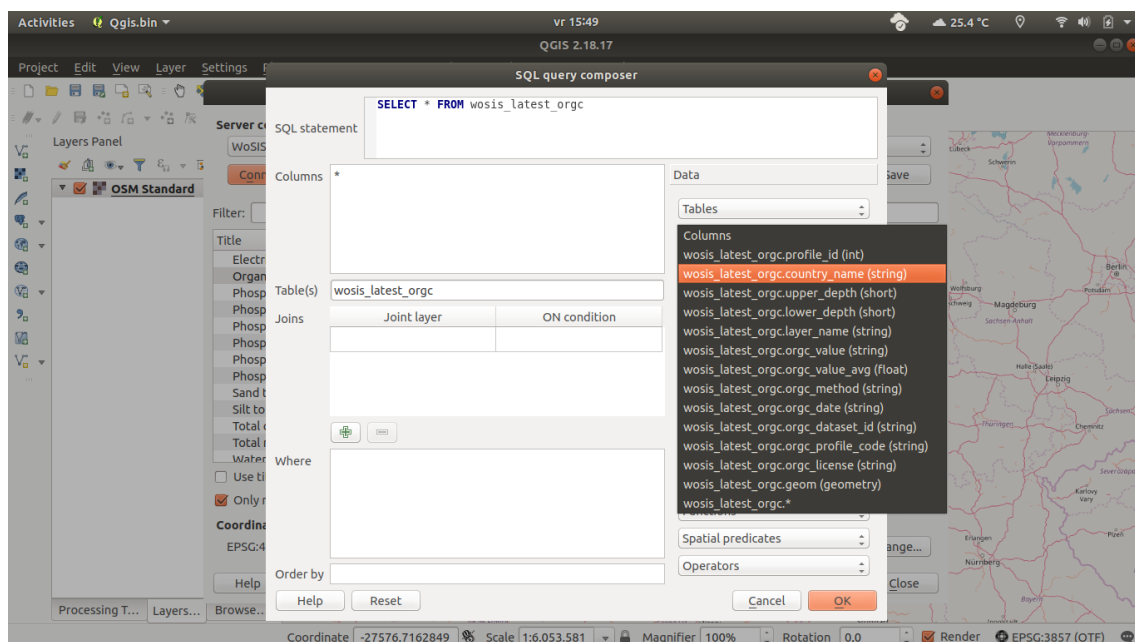
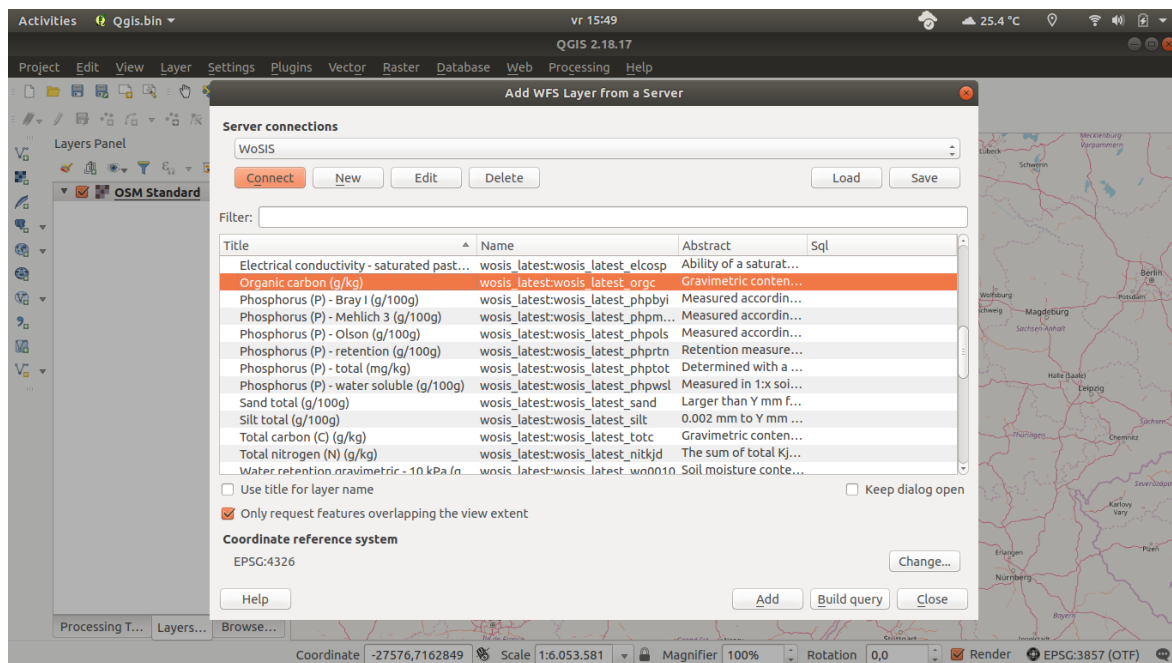
Press '**Add WFS layer**' then '**Connect**' and add layer '**profiles**'.

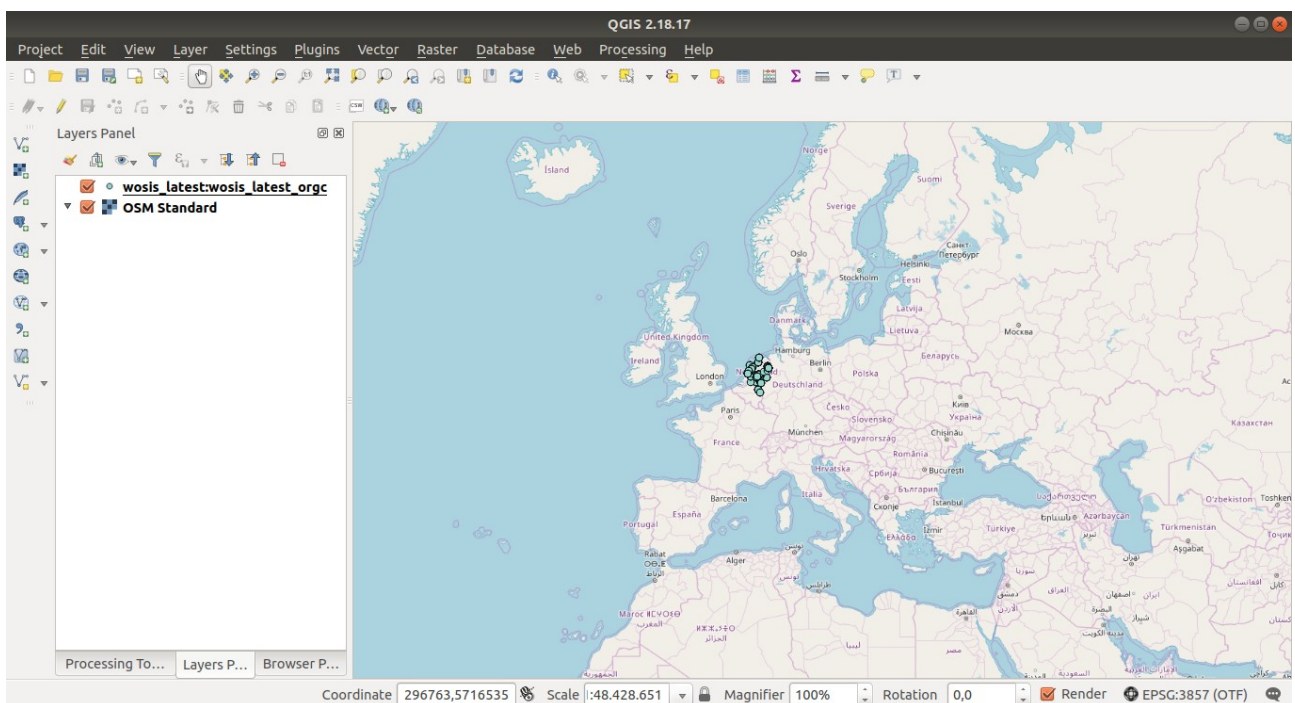
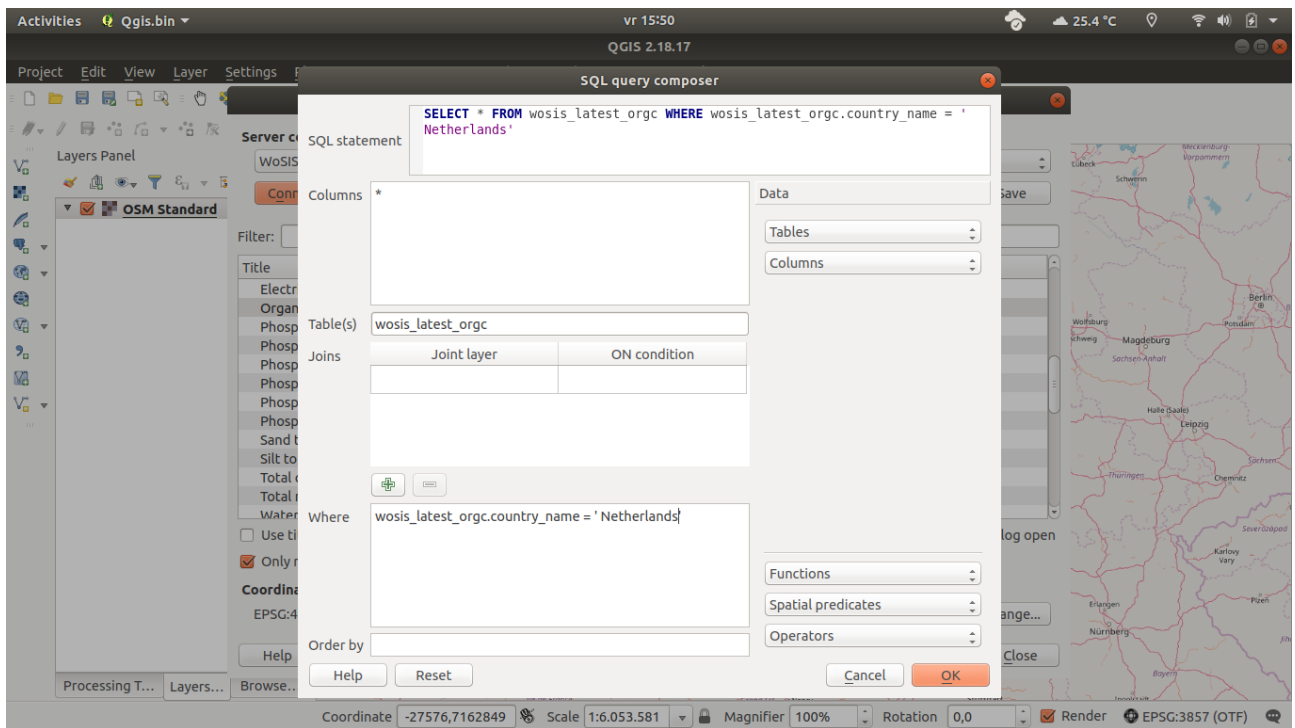


3.2 Filter the data before download it from the server

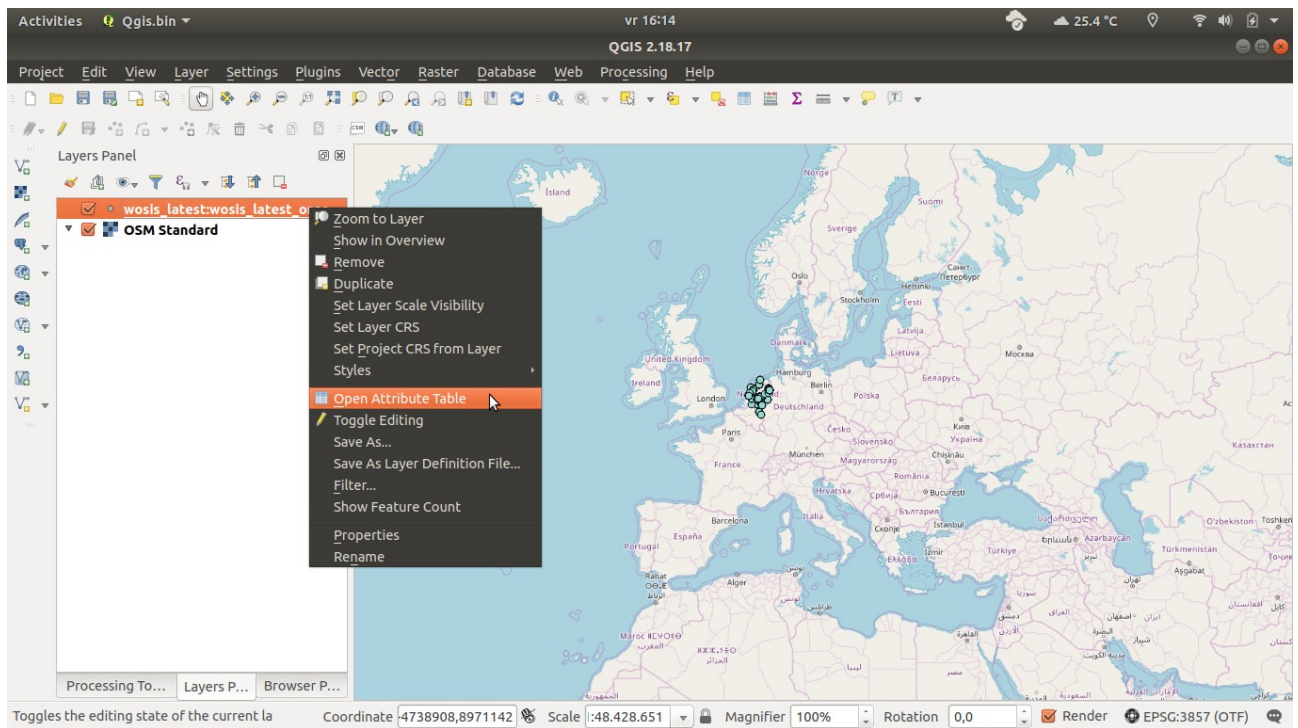
Let's load the layer '**Organic Carbon (g/kg)**' only for the Netherlands. For that, after selecting the layer, click on the '**Build query**' button. Then a new windows will open (SQL query composer) in order to make a SQL query to the server. Click in the box '**Where**', in order to place the cursor there, then click in '**Columns**' → select column '**...country_name**'. You will see that the selected column now appears in the Where box. Now lets just add in front of the column "**= 'Netherlands'**", it should look like this "**wosis_latest_orgc_country_name = 'Netherlands'**". See image below.

Then press '**OK**' → '**Add**' and in the map you will have the layer Organic Carbon (g/kg) only for the Netherlands.





Next, open the attribute table to have a look to the data.

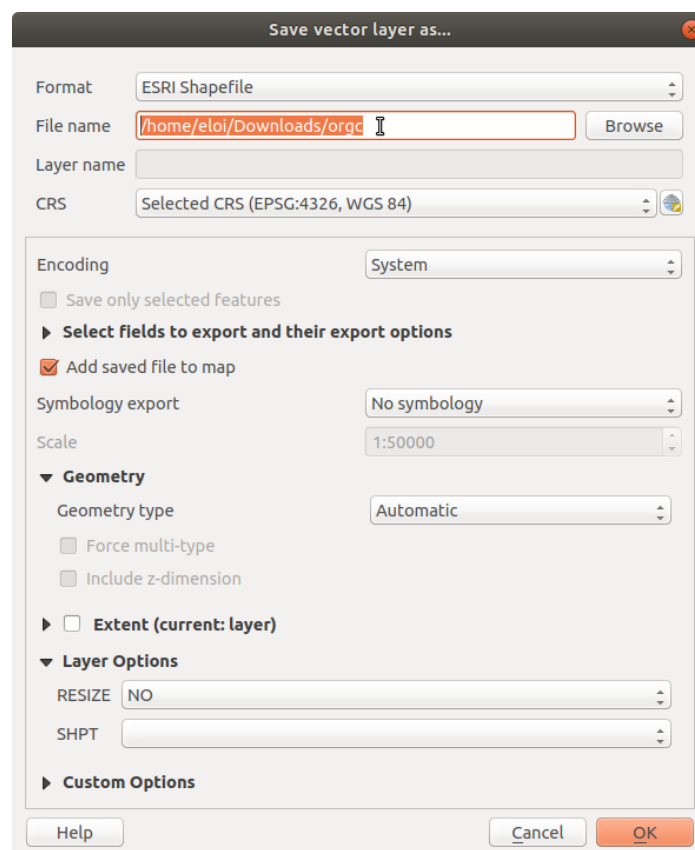
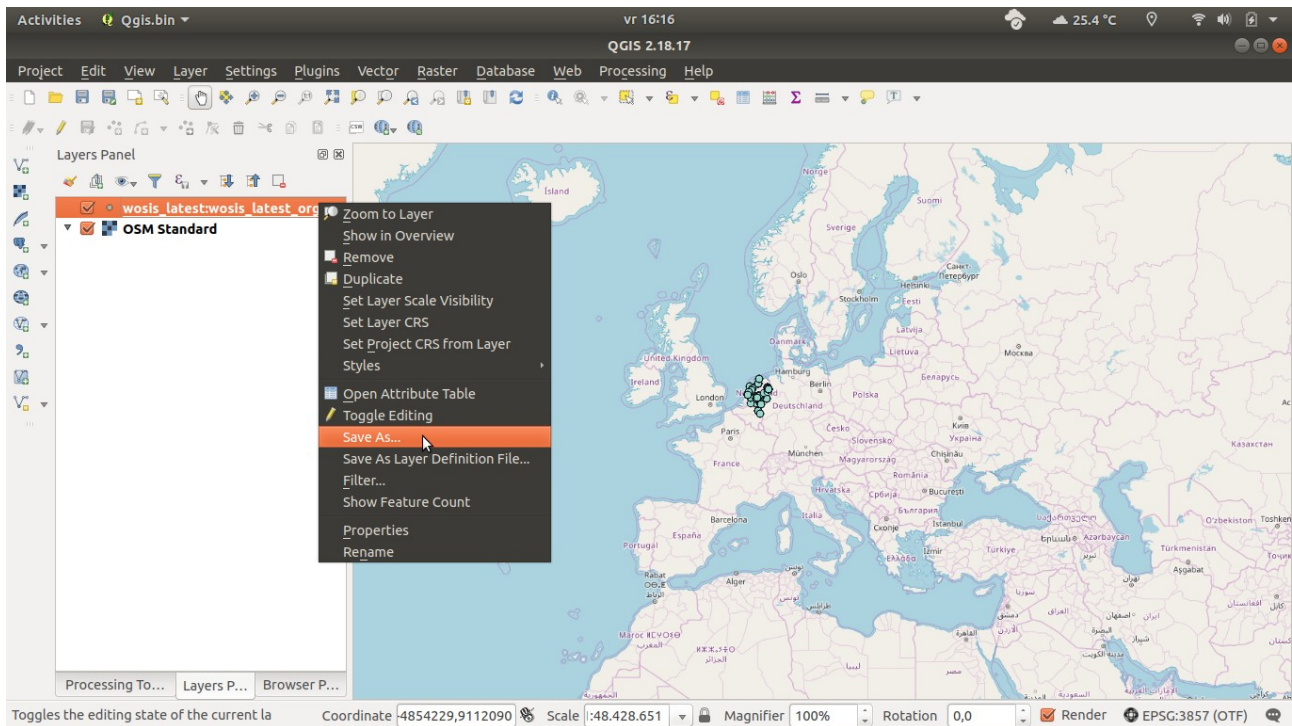


wosis_latest:wosis_latest_orgc :: Features total: 205, filtered: 205, selected: 0										
	profile_id	country_name	upper_depth	lower_depth	layer_name	orgc_value	orgc_value_av	orgc_method	orgc_date	rgc_dataset_i
1	69511	Netherlands	0	8		{1:86.00,2:1...	52.45	{ "1:treatme...	{1:1971-09-...	WD-ISIS
2	69511	Netherlands	8	30		{1:20.10,2:8...	14.4	{ "1:treatme...	{1:1971-09-...	WD-ISIS
3	69511	Netherlands	30	55	Bg	{1:10.50,2:7...	8.85	{ "1:treatme...	{1:1971-09-...	WD-ISIS
4	69511	Netherlands	55	90		{1:8.60,2:7...	8.15	{ "1:treatme...	{1:1971-09-...	WD-ISIS
5	69511	Netherlands	90	105		{1:10.60,2:8...	9.35	{ "1:treatme...	{1:1971-09-...	WD-ISIS
6	69511	Netherlands	105	125	2Ahb	{1:14.30,2:9...	11.65	{ "1:treatme...	{1:1971-09-...	WD-ISIS
7	69511	Netherlands	125	135	2Cb	{1:3.80,2:5...	4.4	{ "1:treatme...	{1:1971-09-...	WD-ISIS
8	69521	Netherlands	0	5	O	{1:495.00}	495	{ "1:treatme...	{1:1989-06-...	WD-ISIS
9	69521	Netherlands	5	11	Ah	{1:41.00}	41	{ "1:treatme...	{1:1989-06-...	WD-ISIS
10	69521	Netherlands	11	21	E	{1:21.00}	21	{ "1:treatme...	{1:1989-06-...	WD-ISIS
11	69521	Netherlands	21	26	Bh1	{1:63.00}	63	{ "1:treatme...	{1:1989-06-...	WD-ISIS
12	69521	Netherlands	26	35	Bh2	{1:28.00}	28	{ "1:treatme...	{1:1989-06-...	WD-ISIS
13	69521	Netherlands	35	55	B/C	{1:10.00}	10	{ "1:treatme...	{1:1989-06-...	WD-ISIS
14	69521	Netherlands	55	105	C	{1:1.00}	1	{ "1:treatme...	{1:1989-06-...	WD-ISIS
15	69521	Netherlands	105	135	2C	{1:1.00}	1	{ "1:treatme...	{1:1989-06-...	WD-ISIS
16	69528	Netherlands	0	21	Ad	{1:11.60}	11.6	{ "1:treatme...	{1:1971-05-...	WD-ISIS

Show All Features

3.3 Export data

To save the data and have it available locally, not depending on an Internet connection, **right click over the layer** and press 'Save as...'. As you will see there are multiple formats available to export.



4. Use GDAL to fetch WoSIS layers

Install this tools from <https://trac.osgeo.org/osgeo4w/>.

Execute on the console the lines in *italic* (although you may see it in more than one line, it is one line!). In green is the output. We will use the tools *ogr2ogr* and *ogrinfo*. For more information please visit the official website (http://www.gdal.org/ogr_utilities.html).

4.1. Listing available layers in the WFS service.

ogrinfo -ro WFS:http://data.isric.org/geoserver/wosis_latest/wfs/

INFO: Open of `WFS:http://data.isric.org/geoserver/wosis_latest/wfs/'
using driver `WFS' successful.

1: wosis_latest:wosis_latest_bdfi33 (Point)
2: wosis_latest:wosis_latest_bdfiad (Point)
3: wosis_latest:wosis_latest_bdfifm (Point)
4: wosis_latest:wosis_latest_bdfins (Point)
5: wosis_latest:wosis_latest_bdfiod (Point)
6: wosis_latest:wosis_latest_bdws33 (Point)
7: wosis_latest:wosis_latest_bdwsns (Point)
8: wosis_latest:wosis_latest_bdwsod (Point)
9: wosis_latest:wosis_latest_tceq (Point)
10: wosis_latest:wosis_latest_cecnsp (Point)
11: wosis_latest:wosis_latest_cecph7 (Point)
12: wosis_latest:wosis_latest_cecph8 (Point)
13: wosis_latest:wosis_latest_clay (Point)
14: wosis_latest:wosis_latest_cfgr (Point)
15: wosis_latest:wosis_latest_cfvo (Point)
16: wosis_latest:wosis_latest_ecec (Point)
17: wosis_latest:wosis_latest_elco1x (Point)
18: wosis_latest:wosis_latest_elcons (Point)
19: wosis_latest:wosis_latest_elcosp (Point)
20: wosis_latest:wosis_latest_orgc (Point)
21: wosis_latest:wosis_latest_phpbyi (Point)
22: wosis_latest:wosis_latest_phpmh3 (Point)
23: wosis_latest:wosis_latest_phpols (Point)
24: wosis_latest:wosis_latest_phprt (Point)
25: wosis_latest:wosis_latest_phptot (Point)
26: wosis_latest:wosis_latest_phpws1 (Point)
27: wosis_latest:wosis_latest_sand (Point)
28: wosis_latest:wosis_latest_silt (Point)
29: wosis_latest:wosis_latest_totc (Point)
30: wosis_latest:wosis_latest_nitkjd (Point)
31: wosis_latest:wosis_latest_wg0010 (Point)
32: wosis_latest:wosis_latest_wg0100 (Point)
33: wosis_latest:wosis_latest_wg1500 (Point)
34: wosis_latest:wosis_latest_wg0200 (Point)
35: wosis_latest:wosis_latest_wg0033 (Point)
36: wosis_latest:wosis_latest_wg0500 (Point)
37: wosis_latest:wosis_latest_wg0006 (Point)
38: wosis_latest:wosis_latest_wv0010 (Point)
39: wosis_latest:wosis_latest_wv0100 (Point)
40: wosis_latest:wosis_latest_wv1500 (Point)
41: wosis_latest:wosis_latest_wv0200 (Point)
42: wosis_latest:wosis_latest_wv0033 (Point)
43: wosis_latest:wosis_latest_wv0500 (Point)

44: wosis_latest:wosis_latest_wv0006 (Point)
45: wosis_latest:wosis_latest_phca (Point)
46: wosis_latest:wosis_latest_phaq (Point)
47: wosis_latest:wosis_latest_phkc (Point)
48: wosis_latest:wosis_latest_phnf (Point)
49: wosis_latest:wosis_latest_profiles (Point)

4.2. Display layer properties.

```
ogrinfo -so -noextent WFS:http://data.isric.org/geoserver/wosis_latest/wfs/ wosis_latest_bdfi33
```

```
INFO: Open of `WFS:http://data.isric.org/geoserver/wosis_latest/wfs/'  
      using driver `WFS' successful.
```

```
Layer name: wosis_latest:wosis_latest_bdfi33
```

```
Metadata:
```

```
  ABSTRACT=Bulk density of the fine earth fraction < 2 mm, equilibrated at 33 kPa
```

```
  KEYWORD_1=features
```

```
  KEYWORD_2=wosis_latest_bdfi33
```

```
  TITLE=Bulk density fine earth - 33 kPa (kg/dm³)
```

```
Geometry: Point
```

```
Feature Count: 76728
```

```
Extent: (-171.927505, -77.848663) - (161.600617, 76.228333)
```

```
Layer SRS WKT:
```

```
GEOGCS["WGS 84",  
  DATUM["WGS_1984",  
    SPHEROID["WGS 84",6378137,298.257223563,  
      AUTHORITY["EPSG","7030"]],  
    AUTHORITY["EPSG","6326"]],  
  PRIMEM["Greenwich",0,  
    AUTHORITY["EPSG","8901"]],  
  UNIT["degree",0.0174532925199433,  
    AUTHORITY["EPSG","9122"]],  
  AUTHORITY["EPSG","4326"]]
```

```
Geometry Column = geom
```

```
gml_id: String (0.0) NOT NULL
```

```
profile_id: Integer (0.0)
```

```
country_name: String (0.0)
```

```
upper_depth: Integer(Int16) (0.0)
```

```
lower_depth: Integer(Int16) (0.0)
```

```
layer_name: String (0.0)
```

```
bdfi33_value: String (0.0)
```

```
bdfi33_value_avg: Real(Float32) (0.0)
```

```
bdfi33_method: String (0.0)
```

```
bdfi33_date: String (0.0)
```

```
bdfi33_dataset_id: String (0.0)
```

```
bdfi33_profile_code: String (0.0)
```

```
bdfi33_license: String (0.0)
```

4.3. Listing all the points attributes of the layer wosis_latest_bdfi33, with a spatial filter (xmin ymin xmax ymax).

```
ogrinfo -ro -noextent WFS:http://data.isric.org/geoserver/wosis_latest/wfs/ wosis_latest_bdfi33  
-spat 0.0 0.0 2961766.25 3798856.75
```

```
(...)
```

4.4. Retrieving the features where country_name = 'Albania' AND lower_depth < 30

ogrinfo -ro -noextent -where "country_name = 'Albania' AND lower_depth < 30"
WFS:http://data.isric.org/geoserver/wosis_latest/wfs/ wosis_latest_bdfi33

INFO: Open of `WFS:http://data.isric.org/geoserver/wosis_latest/wfs/'
using driver `WFS' successful.

Layer name: wosis_latest:wosis_latest_bdfi33

Metadata:

ABSTRACT=Bulk density of the fine earth fraction < 2 mm, equilibrated at 33 kPa

KEYWORD_1=features

KEYWORD_2=wosis_latest_bdfi33

TITLE=Bulk density fine earth - 33 kPa (kg/dm³)

Geometry: Point

Feature Count: 31

Layer SRS WKT:

GEOGCS["WGS 84",
DATUM["WGS_1984",
SPHEROID["WGS 84",6378137,298.257223563,
AUTHORITY["EPSG","7030"]],
AUTHORITY["EPSG","6326"]],
PRIMEM["Greenwich",0,
AUTHORITY["EPSG","8901"]],
UNIT["degree",0.0174532925199433,
AUTHORITY["EPSG","9122"]],
AUTHORITY["EPSG","4326"]]

Geometry Column = geom

gml_id: String (0.0) NOT NULL

profile_id: Integer (0.0)

country_name: String (0.0)

upper_depth: Integer(Int16) (0.0)

lower_depth: Integer(Int16) (0.0)

layer_name: String (0.0)

bdfi33_value: String (0.0)

bdfi33_value_avg: Real(Float32) (0.0)

bdfi33_method: String (0.0)

bdfi33_date: String (0.0)

bdfi33_dataset_id: String (0.0)

bdfi33_profile_code: String (0.0)

bdfi33_license: String (0.0)

OGRFeature(wosis_latest:wosis_latest_bdfi33):837045

gml_id (String) = wosis_latest_bdfi33.837045

profile_id (Integer) = 175197

country_name (String) = Albania

upper_depth (Integer(Int16)) = 0

lower_depth (Integer(Int16)) = 16

layer_name (String) = Ap

bdfi33_value (String) = {1:1.50,2:1.44,3:1.84}

bdfi33_value_avg (Real(Float32)) = 1.59

bdfi33_method (String) = {"1:calculation = not specified, corrections = not specified, sample type = not specified,
measurement condition = equilibrated at 33 kPa (~1/3 bar)","2:calculation = not specified, corrections = not specified,
measurement condition = equilibrated at 33 kPa (~1/3 bar), sample type = clod reconstituted from < 2 mm sample
formed by wetting and dessication cycles that stimulate reconsolidating by water in a field setting","3:sample type = not
specified, corrections = not specified, calculation = not specified, measurement condition = equilibrated at 33 kPa (~1/3
bar)"}
bdfi33_date (String) = {1:1994-03-31,2:1994-03-31,3:1994-03-31}

bdfi33_dataset_id (String) = US-NCSS

bdfi33_profile_code (String) = 94P0509

bdfi33_license (String) = CC-BY

POINT (19.416666 40.715557)

```

OGRFeature(wosis_latest:wosis_latest_bdfi33):837052
  gml_id (String) = wosis_latest_bdfi33.837052
  profile_id (Integer) = 175198
  country_name (String) = Albania
  upper_depth (Integer(Int16)) = 0
  lower_depth (Integer(Int16)) = 17
  layer_name (String) = Ap
  bdfi33_value (String) = {1:1.49,2:1.45,3:1.78}
  bdfi33_value_avg (Real(Float32)) = 1.57
  bdfi33_method (String) = {"1:calculation = not specified, corrections = not specified, sample type = not specified,
measurement condition = equilibrated at 33 kPa (~1/3 bar)","2:calculation = not specified, corrections = not specified,
measurement condition = equilibrated at 33 kPa (~1/3 bar), sample type = clod reconstituted from < 2 mm sample
formed by wetting and dessication cycles that stimulate reconsolidating by water in a field setting","3:sample type = not
specified, corrections = not specified, calculation = not specified, measurement condition = equilibrated at 33 kPa (~1/3
bar)"}
  bdfi33_date (String) = {1:1994-04-01,2:1994-04-01,3:1994-04-01}
  bdfi33_dataset_id (String) = US-NCSS
  bdfi33_profile_code (String) = 94P0510
  bdfi33_license (String) = CC-BY
  POINT (19.483334 40.34528)
  (...)

```

4.5. Download layer in CSV format.

```

ogr2ogr -f "CSV" /home/user/Downloads/wosis_latest_bdfi33.csv
WFS:http://data.isric.org/geoserver/wosis_latest/wfs/ wosis_latest_bdfi33

```

5. Load WoSIS data in R

working directory

```
setwd("/home/user/Downloads/")
```

download

```
download.file("ftp://public:public@ftp.isric.org/wosis_latest/wosis_latest_orgc.tsv",  
"wosis_latest_orgc.tsv")
```

read

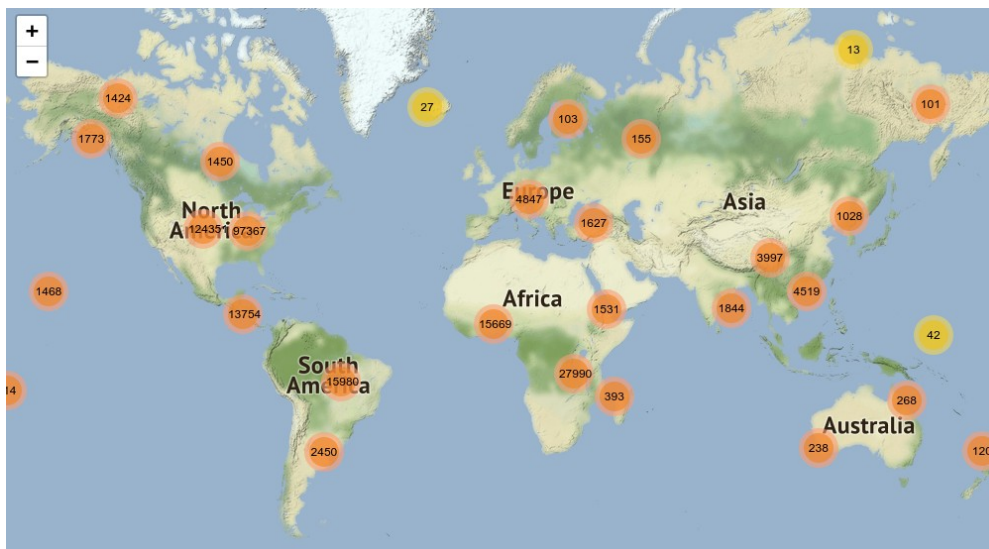
```
orgc = read.table("wosis_latest_orgc2.tsv", sep="\t",quote = "",header=TRUE)
```

look

```
dim(orgc)  
colnames(orgc)  
orgc[1:10, 1:8]
```

plot

```
hist(log(orgc[, "orgc_value_avg"]))  
plot(orgc$longitude, orgc$latitude)  
library(leaflet)  
mymap <- leaflet(orgc) %>% addProviderTiles(providers$Stamen.Terrain) %>%  
addMarkers(~longitude, ~latitude, popup = ~paste(as.character(upper_depth),  
as.character(lower_depth), as.character(orgc_value_avg), sep=" | "), label =  
~paste(as.character(upper_depth), as.character(lower_depth), as.character(orgc_value_avg), sep=" |  
"), clusterOptions = markerClusterOptions())  
mymap
```



Prepared by Eloi Ribeiro (eloi.ribeiro@wur.nl) for the
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ISRIC – World Soil Information in Wageningen, The Netherlands.