



GGMN Portal Instruction Manual

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Version: 4.5

Introduction

The GGMN portal gives insights on the availability of groundwater monitoring data through space and time. Groundwater level data and changes occurring in groundwater levels can be displayed on a regional scale. Additional data layers and information are available to understand the monitoring data in a broader water-related context. The web-based software application assists in the spatial and temporal analysis of monitoring data.

Besides the online tools, the GGMN Portal also provides a plugin to work locally on groundwater monitoring data using an open source GIS: QGIS. This provides the power and accessibility of desktop applications, while still using an online database and online viewer.



GGMN Portal

Global 

The global map is the ideal starting point for users that want to stroll through the data. It gives a quick insight on availability of groundwater monitoring data through space and time, and adds extra data layers and information in a broader water-related context.

Regional 

The regional map gives access to the screen that is focused on analyzing more local sets, to display, mean, range and changes of groundwater levels taking a regional perspective.

Log in 

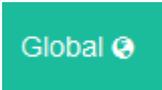
If the privacy settings are adjusted from public to private (via IGRAC) the time series are visible only after logging in. User account and authorization credentials can be obtained via IGRAC. On the top-right of the screen the log-in icon is visible. Logging in gives the possibility to see the time series from the organization the user belongs to. If you click on your name, you reach the Profile page, where you can change password and user information. To log out, you can click on the log-out icon on the top-right side of the page.

Organisation 

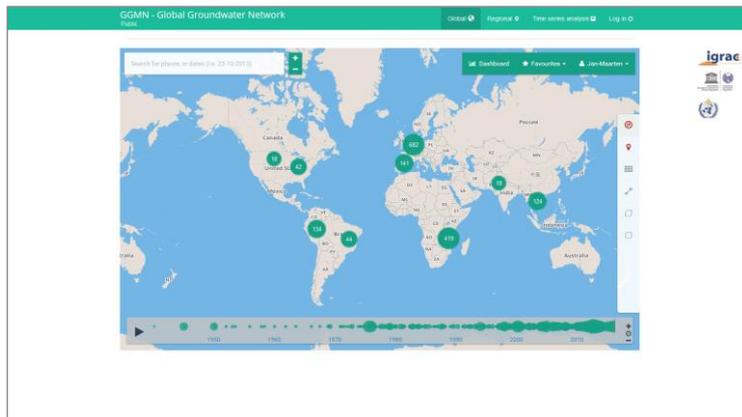
A user can be authorized for multiple organizations. With the organization button one can select easily the organization to show the data for. This selection is necessary to work with non-public data.



Global Portal

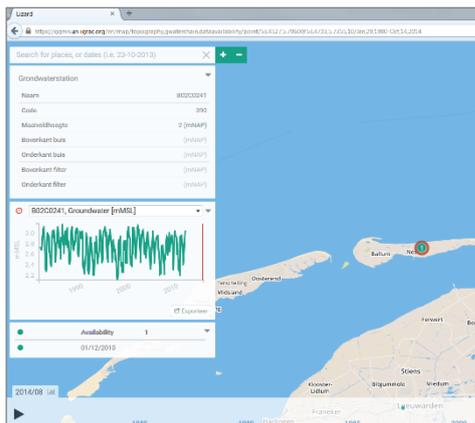


On the global map, the data availability and the locations of the measuring stations are visible. A worldwide overview gives direct information on the number of countries involved in the GGMN. Time series are visible for organisations that accepted to make them publicly available.



The data menu can be folded open by selecting the red compass on the top right. Groundwater station locations can be displayed on the map by selecting the layer 'groundwater'. Information on the monitoring stations and the corresponding time series are presented by selecting the monitoring station icon on the map. A textbox with the station information will be displayed. If the time series are publicly available, the time series will appear below the information box.

To obtain an overview of available data in space and time, the map layer 'availability' can be selected. Zoom in provides more detail where the measuring stations are located. Zooming out to full extent is possible by clicking on the compass icon again. By scrolling through the timeline the start and end date of monitoring stations can be seen.



Other layers include Topography, Landcover, Soil, Digital Elevation Model, Aquifers, displaying the transboundary aquifers of the world map (IGRAC, 2015) and the WHYMAP layer showing the data from the world-wide hydrogeological mapping and assessment program. You can adjust the opacity of the layers by sliding the green line beneath the layer box.



Regional Portal

The regional map is focused on analyzing more local sets and to display basic statistics of the groundwater levels (mean, range and changes) taking a regional perspective.

Statistics

One can see the groundwater data values in two variants: Below Ground Surface (BGS) or Mean Sea Level (MSL).

- **Below Ground Surface:** These layers show the depth to groundwater below the ground surface and are based on water level measurements collected from wells.
- **Mean Sea Level:** Groundwater elevations are shown as meter above or below mean sea level (positive values indicate groundwater elevations above means sea level, negative values indicate groundwater elevations below mean sea level).

Difference: These layers show changes in groundwater levels over time. Each point shows the calculated difference between the measured groundwater levels from the selected time period. The change in groundwater level is plotted on the map only if a measurement exists in both time periods at a well.

Statistic

Daterange

GWmBGS | mean ▼

01-01-1930
to
01-02-2016

- GWmBGS | min
- GWmBGS | max
- GWmBGS | mean
- GWmBGS | range (max - min)
- GWmBGS | difference (mean last - first year)
- GWmMSL | min
- GWmMSL | max
- GWmMSL | mean
- GWmMSL | range (max - min)
- GWmMSL | difference (mean last - first year)

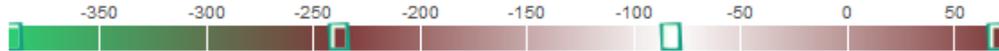


Legend

The primary scale of the legend is set according to the minimum and maximum of the visualized data. The scale can be adjusted by clicking on the bar. A single click adds an extra legend-point; which one can give a custom colour by single-clicking it again. A double click removes a legend point.



Legend



Values on the map

The values are visualized on the map with coloured dots, according the chosen legend. By hovering above the dots, the last value is displayed. By clicking on the dot (monitoring station) a graph with the corresponding time series is presented at the bottom of the page. If no data is available, the dots are coloured gray. The dots are recoloured when selecting a new parameter, a new period or by changing the extent.

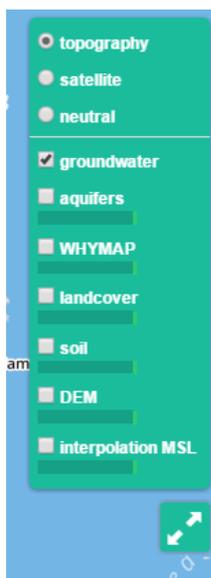


Extra layers

Extra layers can be selected by clicking on the layers-icon.



The layers on the top are the background layers. The transparency of other layers can be adjusted by sliding the transparency bar to the left (more transparent) or to the right (less transparent).



Spatially interpolated groundwater level data



One of the additional layers in the 'regional map' view is the "interpolation MSL". This layers contains a spatially interpolated map of groundwater levels in meters above sea level (if developed by the organization). More information on the development of spatially interpolated groundwater maps can be found in the paragraph 'GGMN and QGIS'. The colours of the interpolation raster can be scaled, using the minimum and maximum value of the raster available in the current extent, by clicking the recolouring-button.



Time series analysis

Time series analysis

This tool consists of a time series analysis for groundwater level data followed by analysis of optimal monitoring frequency. The FREQ tool will consist of the following components:

- **Start page**
 - o Select monitoring well
 - o Select time period
 - o Graph: original time series
- **Detection of trend**
 - o Select: no trend, linear trend, or step trend
 - o alpha significance
 - o graphs: original time series / trend / detrended time series
- **Periodic fluctuations**
 - o Select: number of harmonics
 - o Graph: cumulative periodogram; harmonic series / time series with periodic fluctuations removed
- **Autoregressive model**
 - o Select: correlation lag, order of autoregressive model (p)
 - o Graph: serial correlation coefficient vs time lag; result of autoregressive model
- **Additive model**
 - o Graph: original time series / additive time series model
- **Monitoring frequency**
 - o Graph: Power of trend detection vs number of observations in a trend detection period.

Select data by clicking on a dot in the map and choosing the parameter to work on. The next steps are explained in the information window presented on the online application. During the process of analysis one can easily start over by clicking the bin-icon.

1 Startpage
2 Detection of Trends
3 Periodic Fluctuations
4 Autoregressive Model
5 Additive Model
6 Sampling Frequency

No Time Series Selected

This FREQ-tool consists of a time series analysis for groundwater level data followed by analysis of optimal monitoring frequency. Time series analysis assist to better understand the functioning of the groundwater system, and to identify the effect of abstraction and climate change on groundwater resources. The time series analysis is a step-by-step procedure to identify trends, periodic fluctuations and autoregressive model. These components together form the additive model.

Based on the time series analysis, an identification of the optimal monitoring frequency can be obtained. Monitoring frequency is one of the key parameters for groundwater monitoring network design.

[More information](#)





Import



Groundwater monitoring data can be imported to the GGMN portal via the import screen. To import data, you require admin privileges. The import portal consists of two different parts: Import a File and Interpolate a Time series. After the station has been uploaded to the portal, you can add the groundwater measurements belonging to that station (information on data upload is also available via https://ggmn.lizard.net/doc/import_screen.html#upload-assets-as-a-shapefile).

Upload Groundwater station locations as a shapefile

Station location and related metadata can be uploaded to the GGMN portal using shapefiles. These shapefiles contain information about the station information (assets) and/or meta information on the filter data (nested assets). A shapefile can be uploaded as a zipped archive. The zipfile should contain at least a .dbf, .shp, .shx and .ini file. All files must have the same name. In case of nested assets (data coupled to a filter), this information should be found in the same shapefile record (row) as their assets. The following section provides an example of an .ini file for groundwater stations.

Groundwater stations (no information on filter data)

An .ini file is used to map shapefile attributes to the GGMN database tables, organisations and attributes. An .ini file consists of three sections:

- **[general]:** indicates asset name to upload to and optionally organisation uuid.
- **[columns]:** maps database columns to shapefile columns
- **[default]:** optionally provide default values for columns

A groundwater station ini file would look like this:

```
[general]
asset_name = GroundwaterStation

[columns]
code = ID_1
name = NAME
surface_level = HEIGHT

[defaults]
frequency = daily
scale = 1
```

This example .ini creates a new asset from each record of the shapefile, with:

- A **code** taken from the ID_1 column of the shapefile;
- A **name** taken from the NAME column of the shapefile;
- A **surface_level** taken from the HEIGHT column of the shapefile;
- A **frequency** that defaults to daily;
- A **scale** that defaults to 1, which means this asset can be seen at world scale, when the asset-layer in Lizard-nxt is configured accordingly.

Groundwater station with filter information (Assets with nested assets)

In case of filter information our multiple filters belonging to the same groundwater station another section should be added to the .ini file. A groundwater station with filters (its nested assets) would look like this:



```
[general]
asset_name = GroundwaterStation
nested_asset = Filter

[columns]
code = ID_1
name = NAME
surface_level = HEIGHT

[defaults]
frequency = daily
scale = 1

[nested]
first = 2_code
fields = [code, filter_bottom_level, filter_top_level, aquifer_confinement,
```

The **[nested]** categories describe:

- **first:** indicates the first column in the shapefile that maps lizard columns to shapefile columns. This column and all columns to its right configure nested assets. These columns should be a multiple (the number of nested assets) of the fields.
- **fields:** lizard-nxt fields. Each column in the shapefile (including the 'first') is mapped to these fields in order, without considering the shape column names.

This example .ini creates (a) new nested asset(s) from each record of the shapefile, with:

- A link to an asset that conforms to the asset as described in the Assets without nested assets .ini.
- A **code** taken from the *2_code* column of the shapefile. And a new nested asset with a **filter_bottom_level** for each 5th column from that column onwards;
- A **filter_bottom_level** taken from the column directly next to the *2_code* column of the shapefile. And a new nested asset with a **filter_bottom_level** for each 5th column from that column onwards;
- A **filter_top_level** taken from the column 2 columns next to the *2_code* column of the shapefile. And a new nested asset with a **filter_top_level** for each 5th column from that column onwards;
- A **aquifer_confinement** taken from the column 3 columns next to the *2_code* column of the shapefile. And a new nested asset with a **aquifer_confinement** for each 5th column from that column onwards;
- A **lithology** taken from the column 4 columns next to the *2_code* column of the shapefile and each. And a new nested asset with a **lithology** for each 5th column from that column onwards;

It is possible to add multiple nested assets for one asset. You can copy paste this code in your own .ini file and zip it together with the shapefile.



Import time series (data) as a csv

Time series can be uploaded through a 4 column csv. Select both the organisation you want to upload and the asset type the time series belongs to (e.g. groundwater station). The csv should not contain a header.

timestamp	unit id / name	value	asset id
2015-01-01T00:00:00Z	GWmMSL	248.0	your_own_code_1
2015-01-01T01:00:00Z	GWmBGS	248.0	your_own_code_1
2015-01-01T00:00:00Z	GWmMSL	252.3	your_own_code_2
2015-01-02T05:00:00Z	GWmMSL	234.2	your_own_code_3

The columns should contain:

- **timestamp:** a timestamp in iso8601 format.
- **unit id / name:** This is both the name of the parameter referenced unit name and this will become the time series name.
- **value:** value as either a float or integer number.
- **asset id:** either an asset uuid or an organisation-code (an identifier for an asset, unique for your organisation). In case the assets have been added with a *code* under category *[columns]*.

Multiple timeseries can be uploaded in one .csv-file, by adding more rows. Since a csv should not contain a header, your csv should look like this:

2015-01-01T00:00:00Z	GWmMSL	248.0	your_own_code_1
2015-01-01T01:00:00Z	GWmBGS	248.0	your_own_code_1
2015-01-01T00:00:00Z	GWmMSL	252.3	your_own_code_2
2015-01-02T05:00:00Z	GWmMSL	234.2	your_own_code_3

Example of the content of the time series in a .csv-file. The first column is the date and time of the measurement, in ISO 8601 format, 2nd column contains the parameters, 3rd column the value. The last column is the code linking the time series to its measuring station. This example shows data for three different measuring stations and parameters.

Export

Download 

All the data of the GGMN-portal can be downloaded for further use. The data of the selected organization will be downloaded to a CSV-file. In the CSV-file the station information and time series data are presented. The UUID column can be used to relate the correct time series with the correct station.



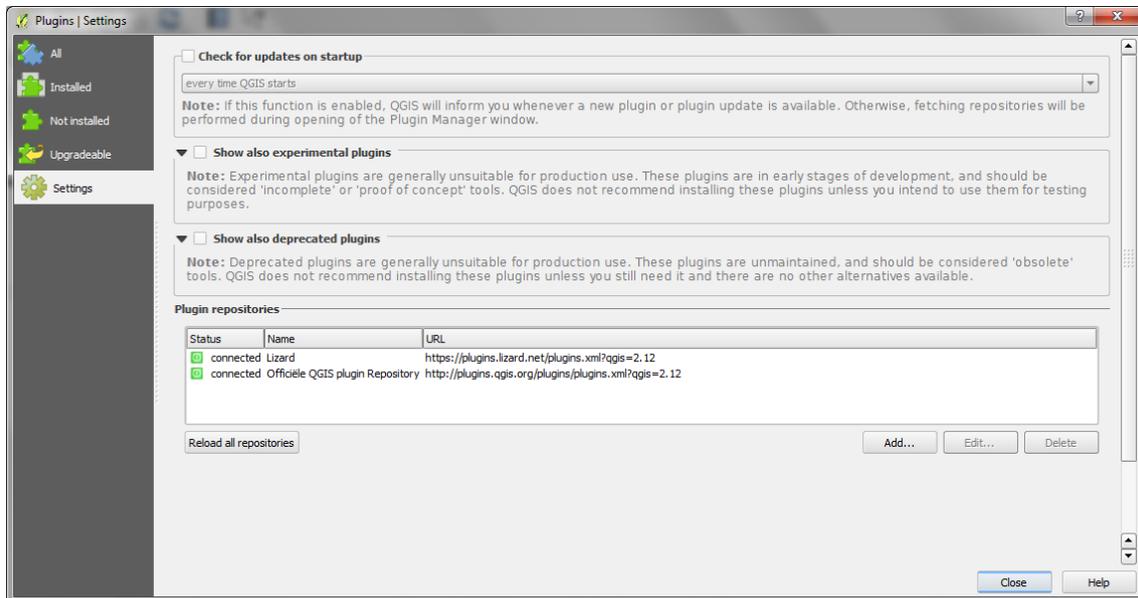
GGMN and QGIS

QGIS is an open source Geographic Information System (GIS), that aims to be user-friendly providing common functions and features. This tool is useful for data viewing, editing and analysis. For simple interaction between QGIS and the GGMN-database (named Lizard) a plug-in has been developed. The GGMN Lizard integration plug-in enables users to download data, add custom 'virtual' points (meant for interpolation) and upload groundwater interpolation rasters to the database. After uploading, the rasters can be seen in the GGMN-portal.

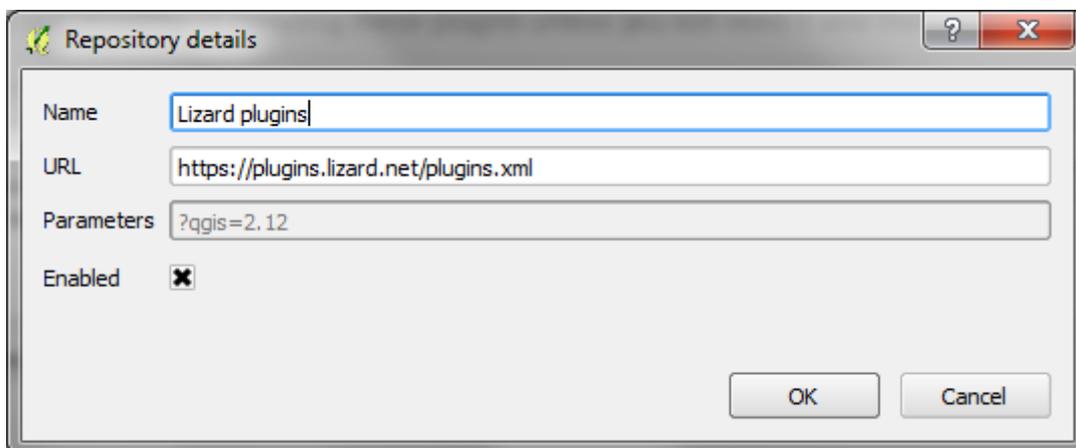
The plug-in has been tested for QGIS 2.8 (stable version) and QGIS 2.12 (latest version). The screenshots used in this manual are from QGIS 2.12.

Installing the plugin

To install the plugin, go to the menu: Plugins-> Manage and Install Plugins... -> select Settings

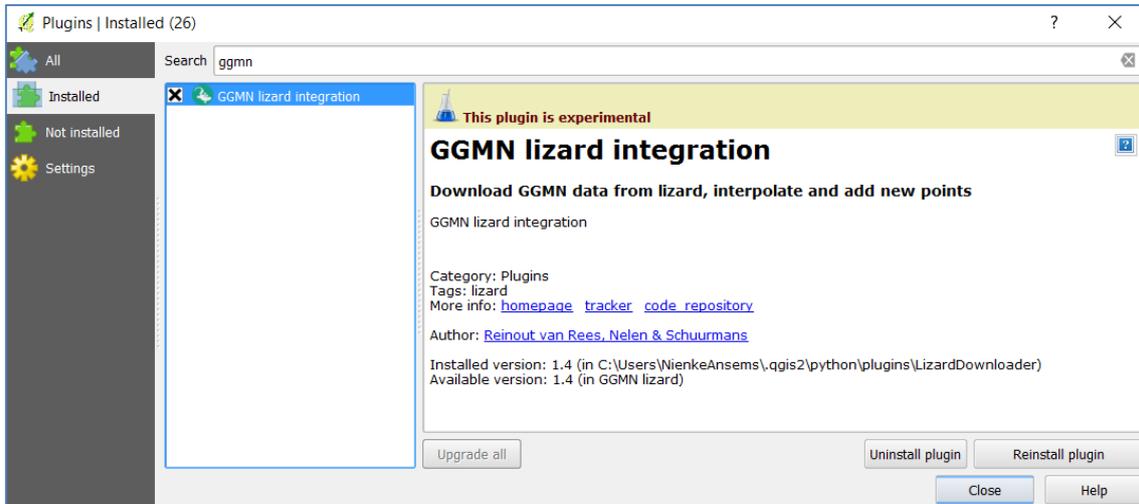


Click on 'Add' under the Plugin-repositories part -> use an applicable name (e.g. Lizard plugins) and type the following URL: <https://plugins.lizard.net/plugins.xml>. Click on 'OK' to create the repository.





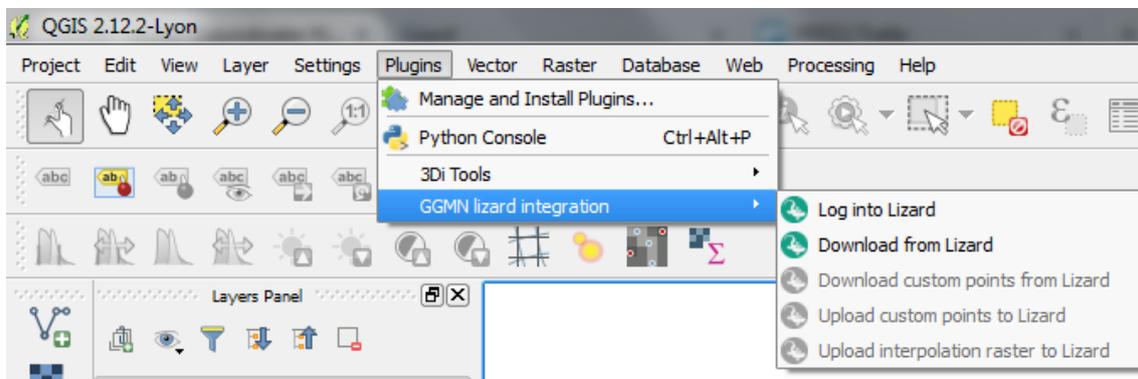
Next, select the 'All' tab and search for 'ggmn'.



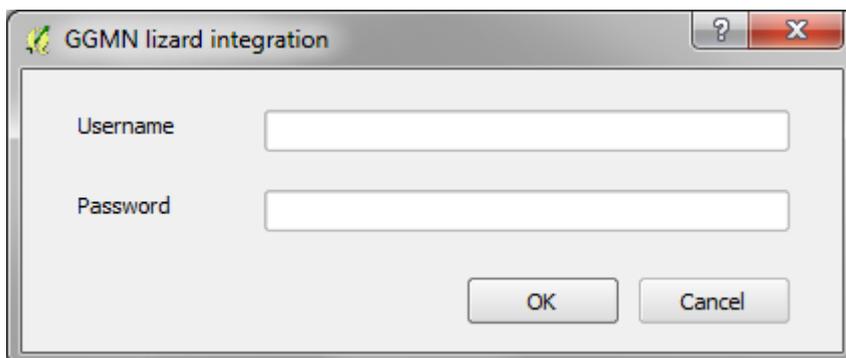
Select the 'GGMN lizard integration' plug-in and click on 'Install plugin'. After installation, the plug-in has been added to the Plugins-menu in QGIS.

Log in

For downloading the data of your organisation you need to log in. Go to the menu bar, select Plugins-> GGMM Lizard integration -> Log into Lizard.



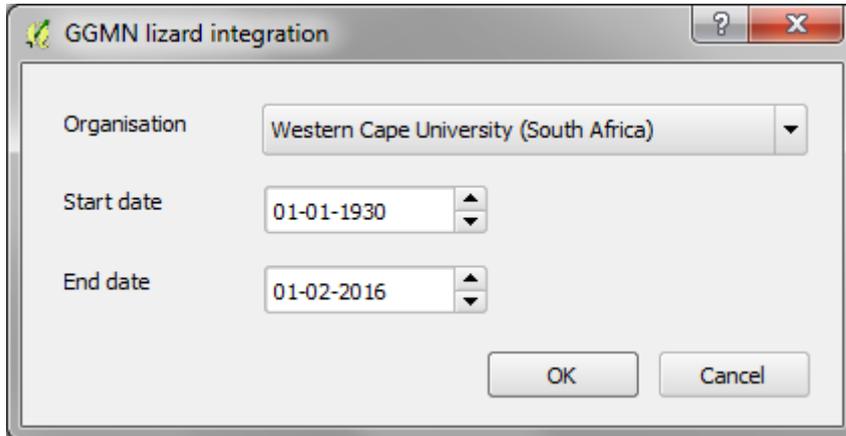
Insert your Username and Password and click 'Ok'.



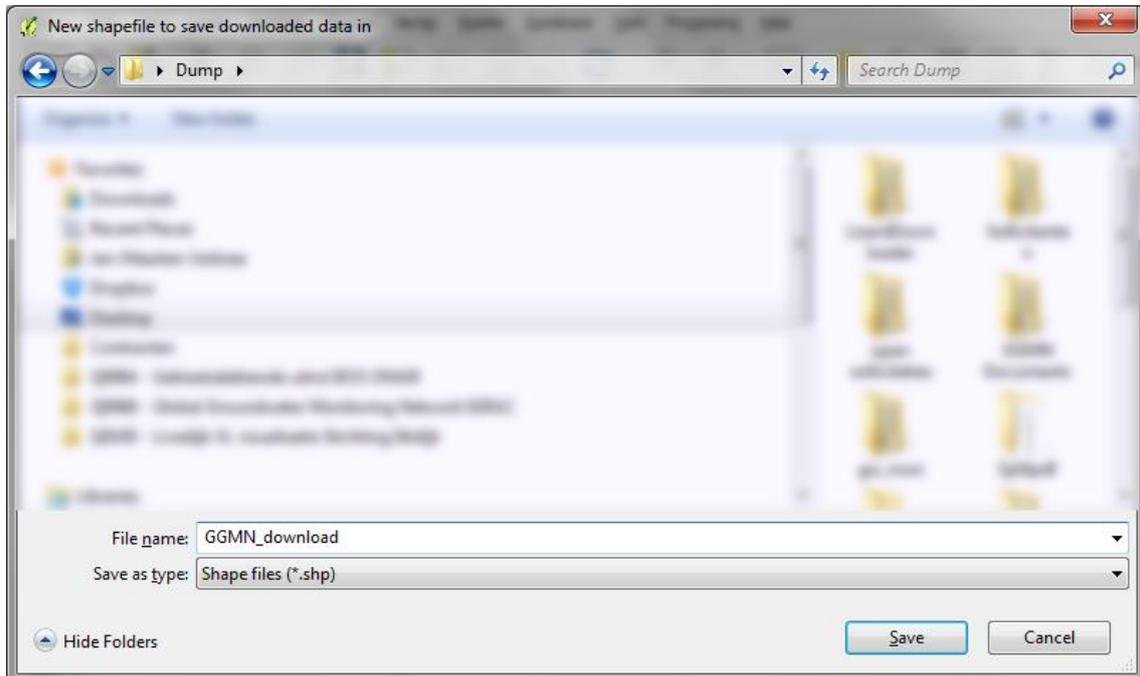


Download data

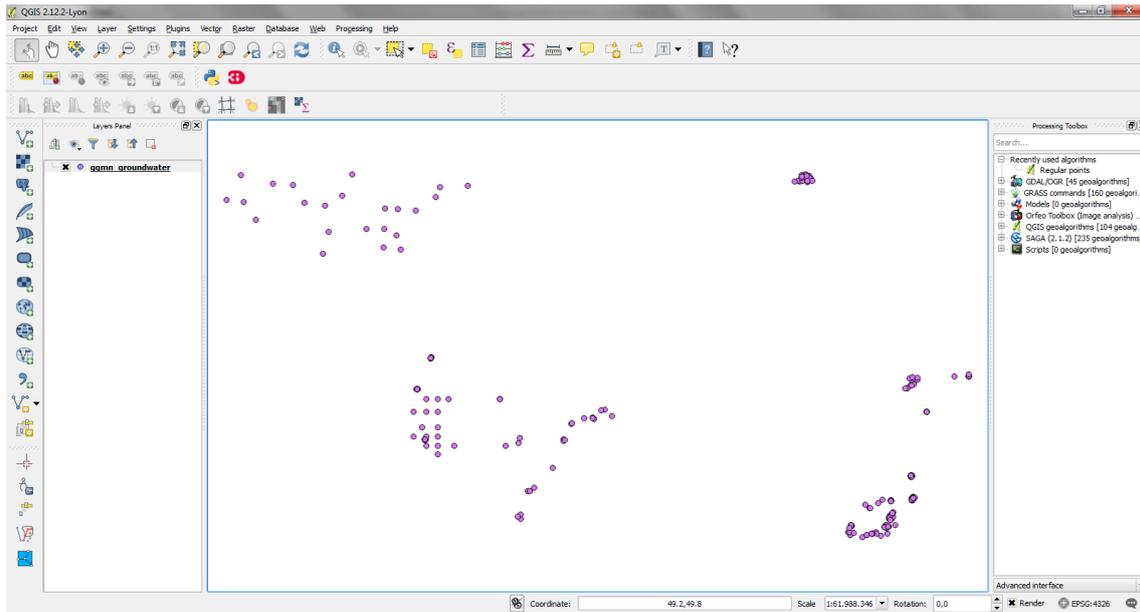
For downloading the data of your organisation you need to log in. Go to the menu bar, select Plugins-> GGMN Lizard integration -> Download from Lizard. If you are authorized to see data of multiple organisation you can select the organisation you want to download data from. You also have to select a period, by choosing a Start date and an End date. The data is download with values in the format 'mean sea level'.



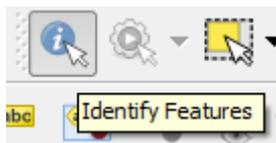
After clicking OK the plug-in asks to enter a filename for the file to save the data to, e.g. GGMN_download. By clicking Ok the data is downloaded and a new layer is added to the QGIS-project.



The new layer is opened in a new QGIS-project, if there is no open project. For each point data is download and aggregated to get a single value.



To see the values of a location, make sure that the 'Attributes Toolbar' is visible (click on View -> Toolbars -> Attributes Toolbar if it is unchecked). Then click on the 'Identify Features' icon.



Next, select a location to see the attributes:

Name = name as given when uploaded

Loc_UUID = unique ID of the location (for internal use)

Ts_UUID = unique ID of the time series (for internal use)

Latitude = the latitude of the location

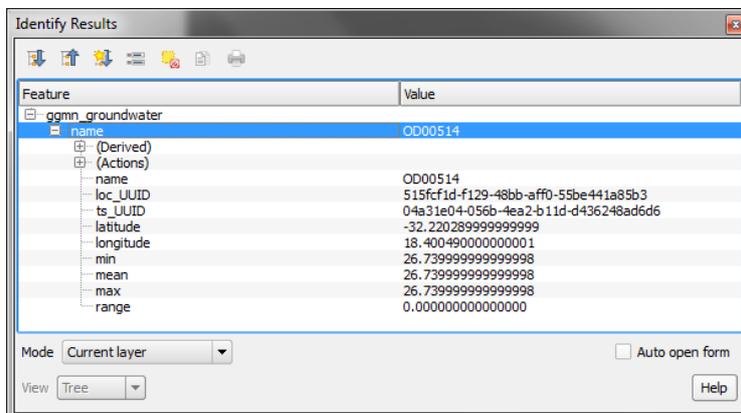
Longitude = the longitude of the location

Min = the minimum of the time series values of the selected period

Mean = the mean of the time series values of the selected period

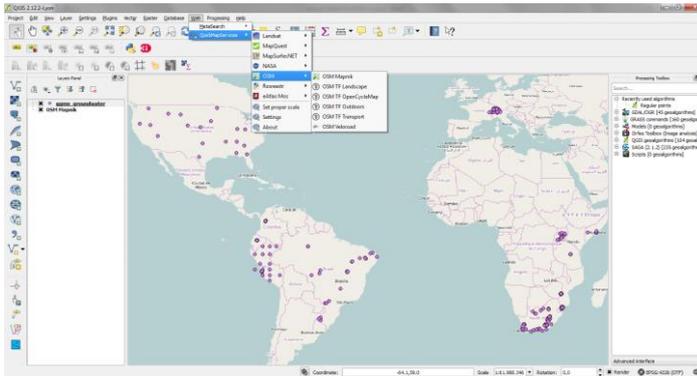
Max = the maximum of the time series values of the selected period

Range = the range (difference between maximum and minimum) of the time series values of the selected period



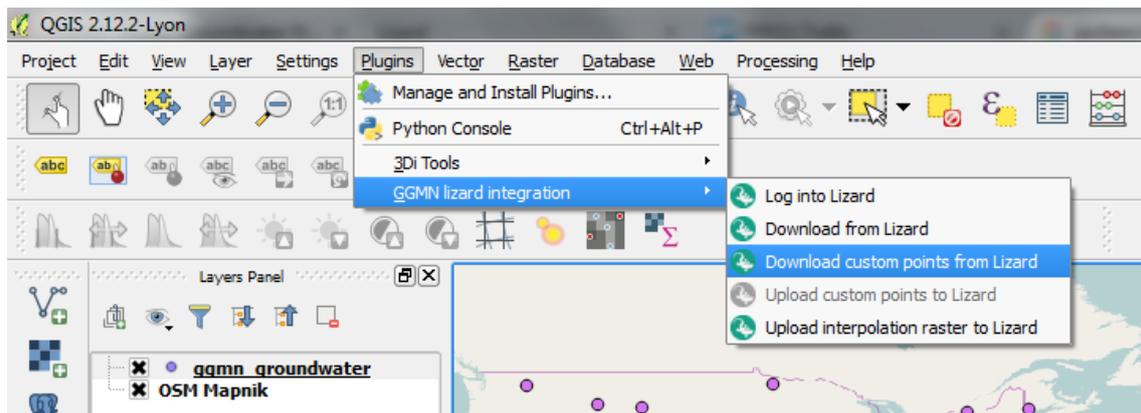


To get background layers, install plugins like QuickMapServices and select a background-layer.

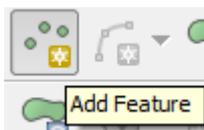


Custom points

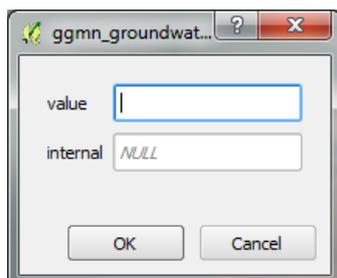
Custom points are 'virtual' measuring point for which one can save values. These values are stored in the Lizard backend for the organisation the user belongs to. Before creating or adding custom points, one needs to click on 'Download custom points from Lizard'. Just like downloading the 'normal' points, a file name has to be given to save the data to. A new layer is created with the custom points. If there are no custom points yet, the layer is empty.



To add a new custom point, click the 'Add feature'-icon (make sure the 'Digitizing' toolbar is displayed)



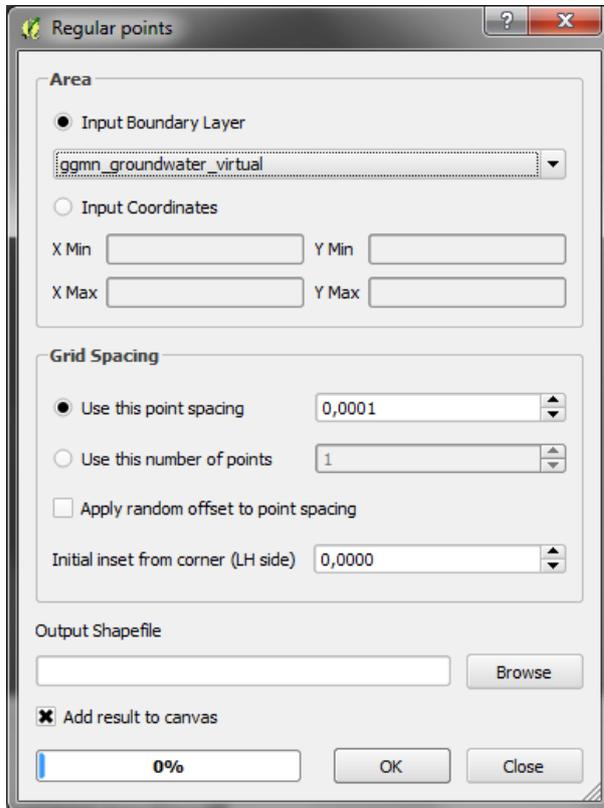
Click on the location where you want to add a custom point. A popup demands for a *value* and an *internal*. Enter a value in meters relative to mean sea level. The internal is used for internal QGIS-registration and needs to remain NULL.





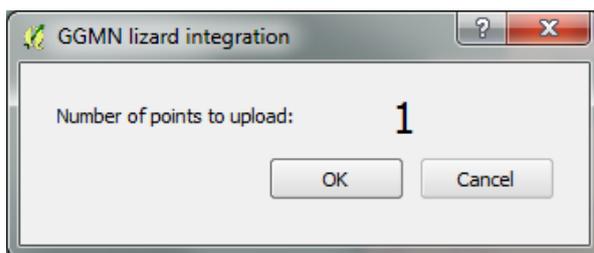
To create multiple points in a simple way, one can choose to use the 'Regular Points'-tool. Select this tool by going to the menu: Vector -> Research Tools -> Regular Points...

Select a layer of a smaller extent by entering coordinates, the grid spacing and an output shapefile.



Uploading custom points

For uploading the custom points to the organisation go to the menu bar, select Plugins-> GGMN Lizard integration -> Upload custom points to Lizard. A popup message gives the number of points to be uploaded and asks for conformation.



Interpolation

An interpolated raster can be created using the QGIS-tools. Select from the menu bar Raster -> Interpolation -> Interpolation or click on the 'Interpolation'-icon on the raster-toolbar.



Upload raster

For uploading the raster tot the database, make sure the raster file is selected and click Plugins-> GGMN Lizard integration -> Upload interpolation raster to Lizard. A message confirms that the upload was successful. The raster will be processed and after a short period displayed in the GGMN portal.

If there was already one raster available for the organisation, the raster will be overwritten.

