

FREE and Open Source Software Tools for WATer Resource Management

FREEWAT User Manual - Volume 4

AkvaGIS (Hydrochemical Analysis Tools and Hydrogeological Analysis Tools)

Version 1.0 September 30th, 2017



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FREEWAT Development has received funding from the following projects:

1. Hydrological part has been developed starting from a former project, named SID&GRID, funded by Regione Toscana through EU POR-FSE 2007-2013 (sidgrid.isti.cnr.it)

2. Porting of SID&GRID under QGis has been performed through funds provided by Regione Toscana to Scuola Superiore S.Anna - Project Evoluzione del sistema open source SID&GRID di elaborazione dei dati geografici vettoriali e raster per il porting negli ambienti QGis e Spatialite in uso presso la Regione Toscana (CIG: ZA50E4058A)

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FOREWORD

FREEWAT is a HORIZON 2020 project financed by the EU Commission under the call WATER INNOVATION: BOOSTING ITS VALUE FOR EUROPE. FREEWAT main result is an open source and public domain GIS-integrated modeling environment for the simulation of water quantity and quality in surface water and groundwater with an integrated water management and planning module. Specific objectives of the FREEWAT project are: to coordinate previous EU and national funded research to integrate existing software modules for water management in a single environment into the GIS-based FREEWAT platform and to support the FREEWAT application in an innovative participatory approach, gathering technical staff and relevant stakeholders in designing scenarios for the proper application of water policies.

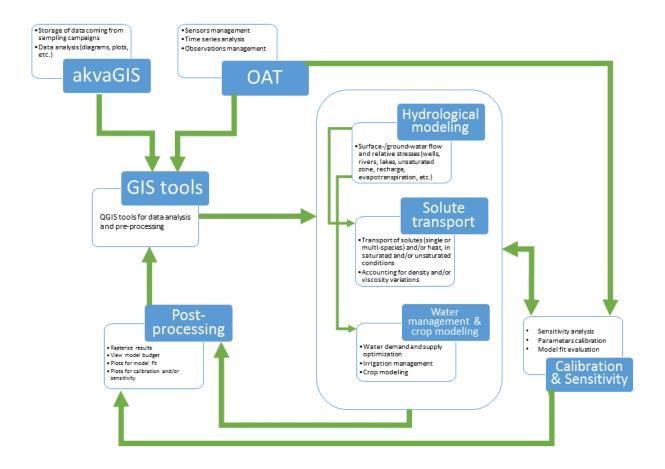
The open source characteristics of the platform allow considering this an initiative "ad includendum", as further research institutions, private developers etc. may contribute to the platform development.

FREEWAT is conceived as a composite plugin for the well-known GIS open source desktop software QGIS (<u>http://qgis.org</u>). The selected reference version of QGIS is the latest LTR (Long Term Release), namely QGIS 2.14: even if this release will be maintained as the reference one, it is worth mentioning that any test performed so far with subsequent versions (e.g. 2.16 and 2.18) worked without experiencing any problem.

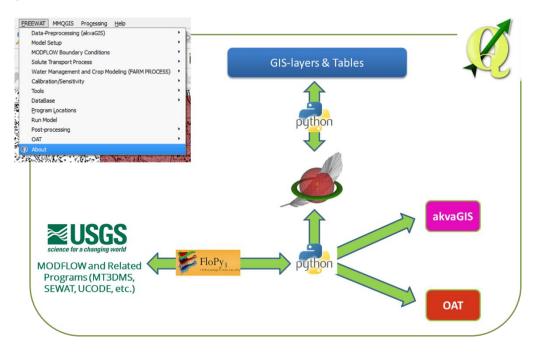
As composite plugin, FREEWAT is designed as a modular ensemble of different tools: some of them can be used independently, while some modules require the preliminary execution of other tools. Capabilities integrated in FREEWAT are:

- Simulation of models related to the hydrological cycle (Volume 1)
- A module for simulating solute transport in the unsaturated/saturated zone, including density and viscosity dependent flow (Volume 2)
- A module for water resource management and optimization of conjunctive use, including issues related to irrigation management in rural environment (Volume 3)
- Tools for the analysis, interpretation and visualization of hydrogeological and hydrochemical data and quality issues (Volume 4)
- A module for time-series processing to support input data processing and advanced model calibration (Volume 5)
- A module for calibration, uncertainty and sensitivity analysis (Volume 6)

The following diagram shows how these different modules are interconnected, taking as reference a standard modeling procedure.



FREEWAT architecture is based on the integration of different software tools (the so called FREEWAT pillars): SQLITE relational database manager, external (free and open source) codes like MODFLOW and MODFLOW-related programs as well as codes specifically developed for the FREEWAT. The way of interconnecting such tools is done via Python programming language, with extensive use of the Python library FloPy. A schematic representation of FREEWAT pillars and their interconnection is showed in the following figure.



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Release history

Abstract

The main goal of this set of tools is to provide FREEWAT platform with different instruments to analyze and interpret the hydrochemical and other hydrogeological data. This set of tools (**AkvaGIS**) perfectly integrated in the platform FREEWAT can be divided into two modules:

- 1. Tools for the hydrochemical analysis and interpretation.
- 2. Hydrogeological analysis and interpretation tools.

The first module, the **Hydrochemical Analysis Tools**, is composed by a geospatial database implemented in Spatialite and a set of tools for improving the harmonization, integration, standardization, visualization and interpretation of hydrochemical data. These tools include different instruments that cover a wide range of methodologies for querying, interpreting, and comparing groundwater quality data and facilitates the pre-processing analysis for being used in the realization of groundwater modelling and other water assessments like river/lake contamination remediation or irrigation water quality evaluation, among others. Some of the tools developed are: ionic balance calculations, chemical time-series analysis, correlation of chemical parameters, regulatory parameters analysis tool, calculation of various common hydrochemical diagrams (Salinity, Schöeller-Berkaloff, Piper, and Stiff), and the link to the free codes EASYQUIM, MIX, and Statistical Analysis, among others. Furthermore, the sub-module allows the generation of maps of the spatial distributions of parameters, diagrams and thematic maps for the parameters measured in the queried area and classified according to the threshold approach established by a given guideline, e.g. WFD.

The second module, the **Hydrogeological Analysis Tools**, is devoted to a better interpretation of the groundwater units, which in turn is crucial in modelling activities to define the conceptual model. The set of tools was developed for improving the management, visualization and interpretation of the hydrogeological data and allow us: (1) to manage and query the hydrogeological measurements (e.g. head, wells abstractions, etc.) performed in wells, piezometers, springs, etc. stored in the database; (2) to apply one or several query criteria (e.g. time interval, groundwater measurement) and to combine them for advanced spatio-temporal queries on the hydrogeological data stored in the database; (3) to create thematic maps (e.g. piezometric maps) of the selected points, time interval and parameters; (4) to calculate some general statistics such as the minimum, maximum or average for each selected hydrogeological parameter, such as head level, depth to the water or pumping rates; (5) to query the depth or the thickness of the defined hydrogeological units and to represent these values in a map as point features, with the possibility to interpolate results.

CHAPTER 1

Users Manual AkvaGIS

AkvaGIS include different instruments to fulfil the aforementioned requirements in an Open source GIS platform: (i) to manipulate large data sets collected for different period of time; (ii) to integrate data from diverse sources that are gathered by different data access techniques and formats; (iii) to manage data with different temporal and spatial scales; and (v) to integrate groundwater information with other relevant data (e.g. water quality) and its pre-processing analysis, particularly to use it as a previous step to outline the numerical groundwater model.

Software Design and Structure

AkvaGIS is built in QGIS (http://www.qgis.osgeo.org), an Open Source GIS User interface supported in the main IOS (Linux, Mac OSX, Windows and Android) and is a widely used GIS open source platform with a large community of developers (Development Team, 2009).

AkvaGIS has been designed as an Object Oriented code and avoiding code repetition in order to reduce errors and improve the maintainability. The code (current version 1.0) is developed in Python and it is freely available in the FREEWAT project repository under the GNU Lesser General Public License v3.0 (GPL-3.0). The code uses different third party libraries (with GPL and MIT/BSD license types). Some of them are distributed with the plugin and others should already be installed in the Python distribution for a correct behavior of the tool (dependencies).

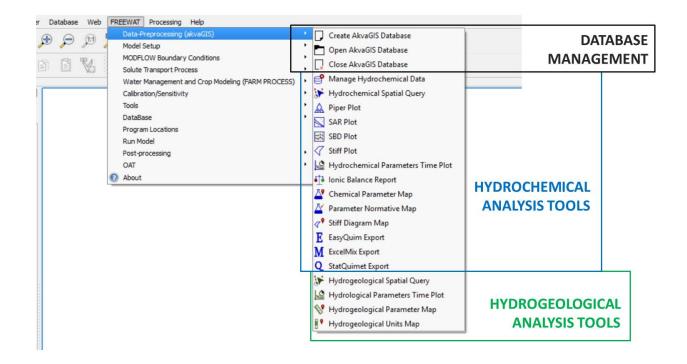
The third party libraries are provided with the plugin distribution: (i) *ChemPlotLib 1.0*: A GPL licensed library that draws the chemical plots provided in the plugin: Stiff diagram, Piper diagrams and SAR plots but also standard plots as 1D line plots. This library offers extensive customization of plots, title labels, axis, edges sizes and colours can be chosen by users and it relies on *Matplotlib 1.5*; (ii) *Openpyxl2.3* (https://openpyxl.readthedocs.io): A MIT licensed library for reading and writing Excel 2010 files. AkvaGIS uses it to export data to Open Office spreadsheets format but the User can save it within the MSExcel formats (xlsx/xlsm/xltx/xltm files); (iii) *Odfpy 1.3* (https://pypi.python.org/pypi/odfpy): A library to read and write OpenDocument v.1.2 files. AkvaGIS uses it to export data to ODF spreadsheets format; (iv) *Pyexcel 0.2* (https://pyexcel.readthedocs.io): A BSD licensed Python Wrapper that provides one API for reading, manipulating and writing data in csv, ods, xls, xlsx and xlsm files. AkvaGIS uses it to export data to different spreadsheets formats.

The dependencies that AkvaGIS apply are: (i) PyQt4: The Qt version 4 Python wrapper; (ii) *Matplotlib 1.5* (http://matplotlib.org/): A Python 2D plotting library which produces publication quality figures in a variety of hard copy formats and interactive environments across platforms. For a more detailed information about the code, please see *Database Documentation Section*.

The AkvaGIS plugin enhances QGIS with hydrochemical and hydrogeological data processing and analysis. All reference and measurement data is stored in a SQLite database (called AkvaGIS database).

The QGIS project (.qgis file) manages the AkvaGIS database (.sqlite file) and additional files that are showed in the canvas or layer panel. The Database Management tools allow users to create, open and close the AkvaGIS database in which the hydrochemical and the hydrogeological spatio-temporal data are stored previous to their representation or analysis.

1.1 AkvaGIS main menu



1.2 Database tools

The **AkvaGIS database** is the core of AkvaGIS Tools and it was implemented in RDBMS Spatialite. Its structure facilitates: 1) the data standardization and harmonization, 2) the storage and management of large amount of spatial features and time-dependent data and 3) the creation and the execution of queries. This database has been designed to include a wide range of information related to hydrochemistry and hydrogeology. The user is able to store all data related to the study zone and to gradually incorporate new data. The information can be easily shared with other users without losing information.

SpatiaLite is an SQLite Database engine with spatial functions added. SQLite is a Database Management System (DBMS) which is simple, robust, easy to use and very lightweight. Each SQLite database is simply a file. You can freely copy it, compress it, and port it between Windows, Linux, MacOs etc.

For more information about SpatiaLite database you can see: http://www.gaia-gis.it/gaia-sins/spatialitecookbook/index.html#family There many free open source browsers to manage and visualize data stored in a database (e.g. Spatialite-gui or DB Browser for SQLite). For instance, these browsers aid the users to upload large datasets at the same time.

The spatial points containing location of collected samples and measurements are the basic information to start using the AkvaGIS tools. These Points can be piezometers, wells, springs, swallow holes, seeps, vanishing points or any other water bodies (i.e. river, lake, sea).

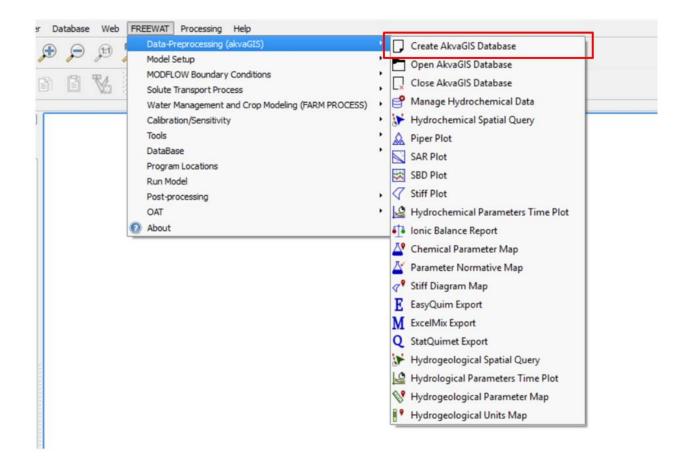
The Basic hydrochemical information related to each spatial point, i.e. *HydrochemicalSamples* and *HydrochemicalMeasurements* tables, contains the dates of when each named sample was taken, the dates of the physical and chemical parameters analysis, as well as their corresponding values and units. The list of analysed parameters is stored in a library/catalogue (*ListHydrochemicalParametersCode*) that can be updated by the user.

Similarly, the basic hydrogeological information is related to the corresponding spatial point where the hydrogeological measures were observed. The measurements date, the measured parameters and the corresponding values and units

are stored in the tables *HydrogeologicalPointsObservations* and *HydrogeologicalPointsMeasurements*. The default hydrogeological parameters available in the library/catalogue *ListHydrogeologicalParametersCode* are: flow rate, depth to water, pressure and head stored. This list of parameters can be customized by the user. To create hydrogeological surfaces units, to be used in a numerical model, the hydrogeological unit observed at each point can be defined and stored in the tables *HydrogeologicalUnits* and *WellsHydrogeologicalUnit*.

Additional information, such as field campaigns, entities in charge of measurements or responsible parties, among others, can also be stored. This information is not essential for using AkvaGIS tools but it is useful to manage the hydrogeological and hydrochemical data. Detailed information of each table are described in section **Database documentation**.

1.2.1 Create AkvaGIS database

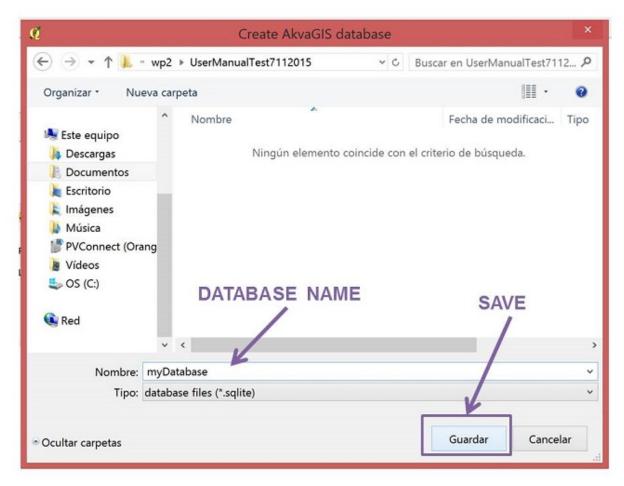


This command enable us to create a new AkvaGIS SpatiaLite database where the hydrochemical and the hydrogeological data will be introduced to be queried by AkvaGIS Analysis Tools.

| ø | Create AkvaGIS Database | ? × |
|--------------|---------------------------|--------|
| Path: | C:\Users\enric\yourDB.sql | Browse |
| Layer Group: | | |
| | STEP 2 | Create |

For further information about the AkvaGIS database, please read Database Documentation Section.

• *Step 1*: Select path in your computer where the database will be created.



• Step 2: Create new Database (empty) and it automatically will be loaded in QGIS.



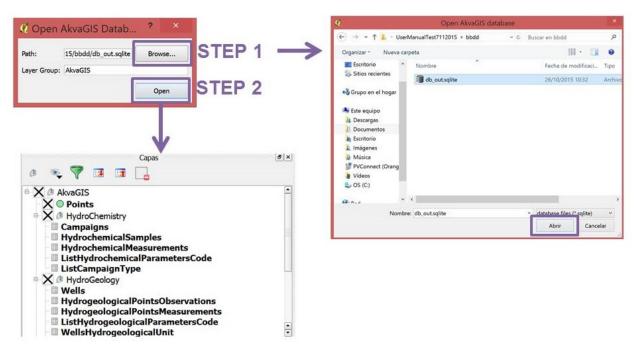
To create new geometric entities (e.g. Points) and entering data in the attribute tables, the user can use the in-built utilities of QGIS (or SpatiaLite utilities).

The **AkvaGIS database** contains the required tables, geospatial entities as well as code lists to enable the user starting a new project from the scratch. Notice that the AkvaGIS tools include also a command composed by a GUI that facilitate the incorporation of hydrochemical data into the database (see section 2.1 *Manage Hydrochemical Data*).

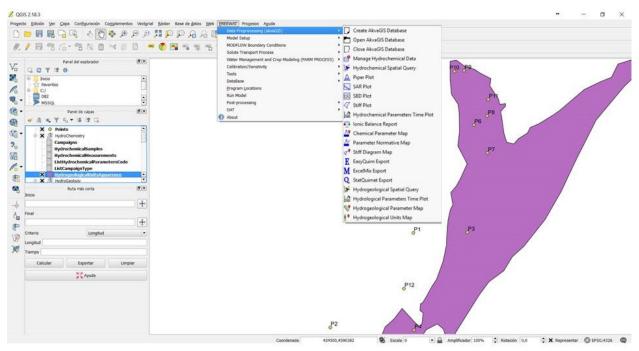
1.2.2 Open AkvaGIS database

| Database Web FREEWAT Processing Help | |
|---|--|
| Data-Preprocessing (akvaGIS) | Create AkvaGIS Database |
| Model Setup MODFLOW Boundary Conditions | Open AkvaGIS Database |
| Solute Transport Process Water Management and Crop Modeling (FARM PROCE Calibration/Sensitivity Tools DataBase Program Locations Run Model Post-processing OAT About | Close AkvaGIS Database Manage Hydrochemical Data Hydrochemical Spatial Query Piper Plot SAR Plot SBD Plot SBD Plot Stiff Plot Hydrochemical Parameters Time Plot Ionic Balance Report Chemical Parameter Map Parameter Normative Map Stiff Diagram Map |
| | EasyQuim Export ExcelMix Export StatQuimet Export Hydrogeological Spatial Query Hydrological Parameters Time Plot Hydrogeological Parameter Map Hydrogeological Units Map |

This command open an existing AkvaGIS database stored in your computer.



- Step 1: Select path in your computer where the database is stored.
- *Step 2*: Automatically the main geometrical entities (Points and HydrogeologicalUnits) and the main attributes table will be shown in the Layers Panel.



The Points entities shown in the figure represent points where samples have been taken to be analysed or points where hydrogeological observations and measurements have been performed (for further information of the database, please see *Database Documentation Section*).

1.2.3 Close AkvaGIS database

| Database Web FREEWAT Processing Help | |
|---|--|
| Data-Preprocessing (akvaGIS) | Create AkvaGIS Database |
| Model Setup | Open AkvaGIS Database |
| MODFLOW Boundary Conditions Solute Transport Process | Close AkvaGIS Database |
| Water Management and Crop Modeling (FARM PROCESS | Manage Hydrochemical Data |
| Calibration/Sensitivity | Hydrochemical Spatial Query |
| Tools | ' 🔊 Piper Plot |
| DataBase | SAR Plot |
| Program Locations Run Model | SBD Plot |
| Post-processing | • 🗸 Stiff Plot |
| OAT | Hydrochemical Parameters Time Plot |
| Ø About | ▲ Ionic Balance Report |
| | Chemical Parameter Map |
| | A Parameter Normative Map |
| | |
| | E EasyQuim Export |
| | M ExcelMix Export |
| | Q StatQuimet Export |
| | 🧩 Hydrogeological Spatial Query |
| | 💆 Hydrological Parameters Time Plot |
| | State of the state |
| | P Hydrogeological Units Map |

Use this command to close and remove the opened database.



Note: This is an important command if you want to open another AkvaGIS Database (avoiding to close the QGIS session).

CHAPTER 2

Hydrochemical analysis tools

The **Hydrochemical Analysis Tools** sub-module of AkvaGIS was created to complement the functionalities of the FREEWAT platform.

These tools facilitate the management of different hydrochemical data with a wide range of methodologies for querying, interpreting, and comparing groundwater quality data and facilitates the pre-processing analysis for being used in the realization of water assessments like river/lake contamination remediation or irrigation water quality evaluation, among others.

The core of these tools is a geospatial database implemented in Spatialite which contains the hydrochemical spatiotemporal information, ready to be represented or analyzed.

The hydrochemical tools was developed for improving the harmonization, integration, standardization, visualization and interpretation of hydrochemical data measured in rivers, lakes, springs, wells, etc. Some of the tools developed are: ionic balance calculations, chemical time-series analysis, correlation of chemical parameters, regulatory parameters analysis tool, calculation of various common hydrochemical diagrams (Salinity, Schöeller-Berkaloff, Piper, and Stiff), and the link to the free codes EASYQUIM, MIX, and Statistical Analysis, among others. Furthermore, the sub-module allows the generation of maps of the spatial distributions of parameters and thematic maps for the parameters measured in the queried area and classified according to the threshold approach established by a given guideline, e.g. WFD.

2.1 Manage Hydrochemical Data

| r Database Web | FREEWAT Processing Help | |
|----------------|---|------------------------------------|
| | Data-Preprocessing (akvaGIS) | Create AkvaGIS Database |
| ~ ~ ~ ~ " | Model Setup | Dpen AkvaGIS Database |
| n n v | MODFLOW Boundary Conditions Solute Transport Process | Close AkvaGIS Database |
| Ward - | Water Management and Crop Modeling (FARM PROCESS) | Manage Hydrochemical Data |
| | Calibration/Sensitivity | Hydrochemical Spatial Query |
| | Tools | Piper Plot |
| 1 | DataBase | SAR Plot |
| | Program Locations Run Model | SBD Plot |
| | Post-processing | , 🗸 Stiff Plot |
| | OAT | Hydrochemical Parameters Time Plot |
| | About | 1 Ionic Balance Report |
| | | Chemical Parameter Map |
| | | Parameter Normative Map |
| | | √ ⁹ Stiff Diagram Map |
| | | EasyQuim Export |
| | | M ExcelMix Export |
| | | Q StatQuimet Export |
| | | Hydrogeological Spatial Query |
| | | Hydrological Parameters Time Plot |
| | | Hydrogeological Parameter Map |
| | | |
| | | Hydrogeological Units Map |

This utility enables the user to modify, insert and visualize hydrochemical data from existing points stored in the database.

Click on Manage Hydrochemical Data command and it opens automatically the management window GUI.

With this GUI, the user can: 1) edit the information of the sampling Points, 2) Add/edit Samples (one by one or massively using .csv files, 3) add/edit campaign, 4) add/edit Hydrochemical Measurements (one by one or massively for each selected sample using .cvs files). In the following paragraphs each of this utilities will be explained:

| Sam | ples | | | | | |
|-----|------------|--------------|-----------|---|---|-----------------------|
| Pun | to P1 | Load Samples | from CSV | file for this point | 2 | Refresh Data |
| | P10 | Sample | | Date | | Edit Point ≼ |
| 1 | 013 | P1-2014 2 | 014-02-12 | 00:00:00.000 | | |
| 2 | Ca P3 | P1-2013 2 | 013-11-26 | 00:00:00.000 | | Add/Edit Sample |
| 3 | Ca P4 | P1_CUP9 1 | 996-12-19 | 00:00:00.000 | | Add/Edit Campaign |
| 4 | Ca P6 | P1_CUP9 1 | | | | X |
| 5 | Camporg. | P1_CUP0 2 | 006-11-08 | 00:00:00.000 | | |
| | surements | 4] | Load Mea | surements from CSV file for this sample | | |
| [| Paramet | er surement | value | Unit | ŕ | Add/Edit Parameters |
| 1 | Benzo (. | . 2014-02 | 0,003 | ug/l (microg/l) | | A 4 4 10 10 14 |
| 2 | 1,2- Dich | 2014-02 | 0,909 | ug/l (microg/l) | - | Add/Edit Measurements |
| - | copper | 2014-02 | 0,606 | mg/l | | |
| 3 | arsenic | 2014-02 | 3,03 | ug/l (microg/l) | | |
| - | or service | | 0.000 | mg/l | | |
| 3 | nitrite | 2014-02 | 0,151 | ngn | : | |

- *1. Point*: Click here to select the point that you want to modify/add a newsample/campaign/hydrochemical measurement.
- 2. *Load Samples from csv file*: Click here to add samples to the selected point from CSV file. The csv file format has to be like akvaGIS tables.

CVS File format: sample; samplingTime; campaignId; fieldname; currentLocation; sampleSize; sampleSizeUom; samleLenght; samplingMethodId; responsiblePartyId; otherChemSamplesDetails; observations. For further information about the contents of this table, please see Database Documentation section.

• *3 Refresh Data button*: This command enables us to visualize and update the editing or the new data included in the database.

Note: This command has to be used after every change in the database applied using this GUI.

| | 3 | Campaig 1 Campaig 2 Campaig 3 Campaig | ig P12-20 | 013 | 2013-1 | Da 5-27 09:26:0 | 02 | Add | Edit Point | | 4 | |
|------------------|--|--|--|---|--|--|---|---|--|--|--|----------------|
| | 3 | 2 Campaig | ig P12-20 | 013 | 2013-1 | | Charles - | Add | /Edit Sample | | | |
| | - | | - | | | -29 00:00:0 | | Add | | | | - |
| | | 3 Campaig | ig P12_C | UP0612 | 2006 1 | | 000.000 | | cur oumps | e | | |
| | | | | | 2006-17 | 2-13 00:00:0 | 000.000 | Add | /Edit Campa | iign | | |
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| de (Ctrl+E) Save | | | | | | | | | - 1 | odate All | Undate Sele | cte |
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• 5. *Add/edit sample*: Click here for adding/editing samples taken from the selected Points. Please, notice that using this function the editing mode of QGIS will be automatically activated. **After the required editions in the table, please use the command of save edits of QGIS**.

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• 6. Add/edit campaign: Click here for adding/ editing campaign information from the selected Points.

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• 7. Load Measurements from csv file: This command allows us to include into the database massively the different hydrochemical measurements performed for the selected sample for the selected point using a CVS file. The csv file format has to be like akvaGIS table.

CVS File format: hydrochemicalParameterCode; resultTime; value; compValue; responsiblePartyId; processId; citationId; otherChemMeasurementsDetails; observations. For further information about the contents of this table, please see *Database Documentation Section*.

• 8. Add/edit Measurements: Click here for adding/ editing measurements.

2.2 Hydrochemical Spatial Query

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This command enable us to create a query for the selected point or set of points on the screen that represents sampling sites (Points). Thereafter, the user select other query criteria such us period of time of sampling or campaigns.

The Hydrochemical Spatial Query created by the user can be stored in the database to the other hydrochemical tools (e.g. piper, stiff, ionic mass balance, etc.) included in akvaGIS toolbar.

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|---|--|--------------------------|--|----------------|------------|------------|--------|---------|
| Query Editor Queries only2Points AllPoints NorthernPoints | Add Remove temove A | Start Date: | ime Interval 27/01/1900 27/01/2014 | | vints) | | | Refresh |
| by date | eried Samples art date 27/0 nd date 27/0 | 1/1990 (†) 1/2012 (†) | | Active Samples | Run Q | uery | | |
| by campaign by points | | | Select All Deselect All | | | | | |
| | Apply Fi | lter | | Activate | Deactivate | Select All | Desele | ct All |
| | | | | | | | | ose |

• *Step 1*: This command to create and add to the database a new query of the selected sampling points (spatial selection) for the desired time interval. Also campaign can be used as a query criteria. Thus, hydrochemical tools can be applied to the queries stored in the database or it can be used in future analysis. Using the command Remove, the selected Query can be deleted from the database and using Remove All, all the queries stored in the database will be deleted.

| 1. | Hydrochemical Spatial Query | | EP 3 | CTED 2 | P10 89 | |
|------|---------------------------------------|--------------------------|--|--------|---|--|
| | | | 7 × | STEP 2 | | |
| | sery Editor | ni Spatial Selection | (Points) | | P11 | |
| | only2Points Start Date: 22/01/2 | 1000 2 171 | | | and the second se | |
| | NorthernPoints Add End Dete: 27/(0.)2 | 1024 C P10 P11 P12 | | | P8 | |
| | Rettove | 12 | | | e ^{P6} | |
| | Ramove AB | 252 | Refresh | K | | |
| | | 97 | | CTED A | P7 | |
| | | 19 | | STEP 4 | ¢ ' | |
| | | | Run Query | | | |
| Acti | chrate/Deactivate Queried Samples | | - TOBER - | | | |
| | filter | Active Samples | | | | |
| . 0 | 10st. dete 27/91/2000 | Active Por | | | | |
| | 100 Abb 22/11/2018 | 1 X P7 | P7-2014 2014-01-19 00:00:00.000 Campaign11 P7-2013 2013-12-22 00:00:00.000 Campaign11 | | | |
| | by campaign (company) (+) | 1 X P7 | P7_CUP5609 2006-09-24 00:30:30.000 Campaign9 | | | |
| | (1) Select Al | 4 X P6 | P6-2014 2014-01-15 00:00.00.000 Campaign11 | P1 | P 3 | |
| | PS Deselect All | 3 X P6 | P6-2013 2013-12-16-00:00:06.000 Campaign11 | 6. | 6 | |
| | 19 | 6 X 15 | P5-2014 2014-01-11 00:00:00.000 Campaign11 | | | |
| | 11 | 7 X P5 | P5-2013 2013-12-08 00:00:00.000 Campaign11 | | | |
| | P12 1-1 | 8 X P5 | P5_CPR2011 2010-05-30 00:00:00.000 Campaign10 | | | |
| | 911 210 | 3 X 13 | P5_CCL0301 2003-81-28 60:00:00.000 Cempeign8 | | | |
| | | 10 X P9 | P9-2014 2014-01-07 00:00:00.000 Campeign11 | P12 | | |
| | Apply Filter | | | | | |

- Step 2: Select (using inbuilt tools of QGIS) the points to be included in the query on the screen.
- *Step 3*: Select the desired time interval to be queried.
- *Step 4*: Refresh for visualize the new query.

Note: This command has to be used after every change in the query applied using this GUI.

| Juery Editor | | Complex T | and Internal | Control | Calentine (D | - Andrew States | | | |
|--|-----------------|--|------------------------------|----------------|--------------|-----------------|-----------------|-------------------|------------|
| Queries | - | 5 | ime Interval | - | Selection (P | oints) | | | |
| only2Points AllPoints NorthernPoints | Add | | 27/01/1900 : 27/01/2014 : | P11 P3 | | | | | |
| UserManual | Remove | | | P6 P7 P8 | | | | | Refresh |
| | temove A | | | P9 | | | | | |
| | | | STE | DF | | ~ | Run Query | | |
| ctivate/Deactivate Q | ueried Sample: | 5 | UIL | | | - | | - | |
| Filter | | | | Active | Samples | 1 | 1 | 1 | L. P |
| by date | Start date 27/0 | and a second | | - | Active | Point | Sample | Date | G |
| | End date 27/0 | 01/2014 | | 1 | × | P7 | P7-2014 | 2014-01-19 00:00: | 00.000 Ca |
| by campaign | Campaign11 | | | 2 | × | P7 | P7-2013 | 2013-12-22 00:00: | 00.000 Ca |
| by points | | | | 3 | × | P7 | P7_CUP0609 | 2006-09-24 00:00: | 00.000 Ca |
| | P7 | | Select All | 4 | × | P6 | P6-2014 | 2014-01-15 00:00: | 00.000 Ca |
| | P6 P9 | | | 5 | × | P6 | P6-2013 | 2013-12-16 00:00: | 00.000 Ca |
| | P8 | | Deselect All | 6 | × | P6 | P6_CUP_7309 | 1973-09-01 00:00: | 00.000 Ca |
| | P3 P11 | | | 7 | × | P9 | P9-2014 | 2014-01-07 00:00: | 00.000 Ca |
| | P10 | | | 8 | × | P9 | P9_CAG0110-004 | 2001-10-24 00:00: | 00.000 Ca |
| | | | | 9 | × | PS | P8-2014 | 2014-01-03 00:00: | 00.000 Ca |
| | | | | 10 | ¥ | PR | PR (11P9612-015 | 1996-17-19 00-00- | 00 000 Ca |
| | | | | | | Deactiva | | | select All |

• Step 5: Run Query.

| Query Editor | | Constant | Time Internal | | Contint | Calantian (C | hinto) | | | |
|---|---------------------------|----------|---|-----|--|--------------|----------|-----------------|-----------------|--------------|
| Queries only2Points AllPoints NorthernPoints UserManual | Add Remove temove A | Start Da | s Time Interval te: 27/01/190 te: 27/01/201 | 0 : | P10 P11 P3 P6 P7 P8 P9 | Selection (F | ST | EP 6 tiona | l) | Refresh |
| | | _ | | | 4 | - | | Run Query | | |
| Activate/Deactivate Filter | Queried Samples | | | | Active | Samples | | | | |
| | Start date 27/0 | 01/1900 | 5 | | | Active | Point | Sample | Date | ci- |
| X by date | End date 27/0 | 01/2014 | 1 | | 1 | × | P7 | P7-2014 | 2014-01-19 00:0 | 0:00.000 Ca |
| X by campaign | Campaign11 | | | | 2 | × | P7 | P7-2013 | 2013-12-22 00:0 | 0:00.000 Ca |
| X by points | | | | | 3 | × | P7 | P7_CUP0609 | 2006-09-24 00:0 | 0:00.000 Ca |
| | P7 | | Select A | u. | 4 | × | P6 | P6-2014 | 2014-01-15 00:0 | 0:00.000 Ca |
| | P6 P9 | | | | 5 | × | P6 | P6-2013 | 2013-12-16 00:0 | 0:00.000 Ca |
| | P8 P3 | | Deselect | All | 6 | × | P6 | P6_CUP_7309 | 1973-09-01 00:0 | 0:00.000 Ca |
| | P3 P11 | | | | 7 | × | P9 | P9-2014 | 2014-01-07 00:0 | 0:00.000 Ca |
| | P10 | | | | 8 | × | P9 | P9_CAG0110-004 | 2001-10-24 00:0 | 0:00.000 Ca |
| | | | | | 9 | × | PS | P8-2014 | 2014-01-03 00:0 | |
| | | | | | 10 | × | DR | PR (1109612-015 | 1995-17-19 00-0 | 0.00 000 (3. |
| | Apply Fi | iter | | | | ctivate | Deactiva | te S | Select All | Deselect All |

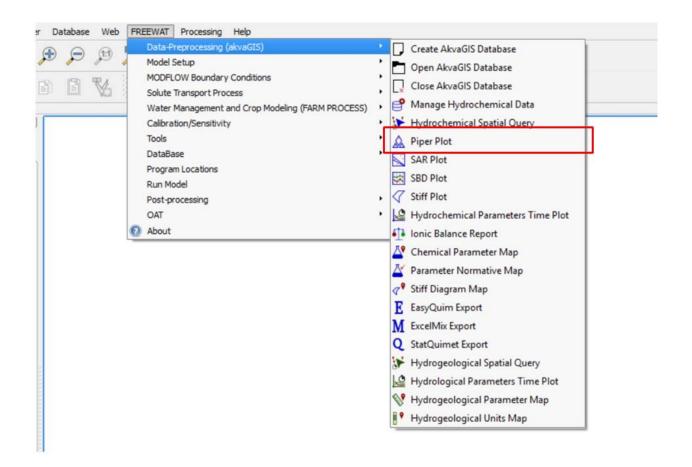
• Step 6: Filter chosen any available query criteria by date, by campaign or by points (optional).

| Query Editor | | Samples | Time Interval | | Spatial : | Selection (F | oin | | | |
|--|-----------------|-----------|--------------------------------|---|------------------|--------------|-------|-----------------|------------------|------------|
| only2Points AllPoints NorthernPoints | Add | Start Dat | e: 27/01/1900 e: 27/01/2014 | | P10 P11 P3 | | ST | EP 7 | | |
| UserManual | Remove | | | | P6 P7 | | (0) | ptiona | al) | Refresh |
| | temove A | | | | PS P9 | | | | | |
| | | | | | | | | _ | | |
| | | | | | | | | Run y | | |
| ctivate/Deactivate | Queried Samples | | | - | - | - | | | | _ |
| Filter | | | | | Active | e Samples | | | | |
| X by date | Start date 27/0 | 01/1900 | 5 | | | Active | Point | Sample | Date | a |
| X of our | End date 27/0 | 01/2014 | 1 | | 1 | × | P7 | P7-2014 | 2014-01-19 00:00 | :00.000 Ca |
| X by campaign | Campaign11 | | 3 | | 2 | × | P7 | P7-2013 | 2013-12-22 00:00 | :00.000 Ca |
| X by points | | | | | 3 | × | P7 | P7_CUP0609 | 2006-09-24 00:00 | :00.000 Ca |
| | P7 | | Select All | | 4 | × | P6 | P6-2014 | 2014-01-15 00:00 | :00.000 Ca |
| | P6 P9 | | | | 5 | × | P6 | P6-2013 | 2013-12-16 00:00 | :00.000 Ca |
| | PS | | Deselect Al | 1 | 6 | × | P6 | P6_CUP_7309 | 1973-09-01 00:00 | :00.000 Ca |
| | P3 P11 | | | | 7 | × | P9 | P9-2014 | 2014-01-07 00:00 | :00.000 Ca |
| | P10 | | | | 8 | × | P9 | P9_CAG0110-004 | 2001-10-24 00:00 | :00.000 Ca |
| | | | | | 9 | × | PS | P8-2014 | 2014-01-03 00:00 | |
| | | | | | 10 | × | DR. | PR (1109612-015 | 1995-17-19 00-00 | -00 000 (7 |
| | | | | | 1000 | | | | elect All D | |

• *Step 7*: Activate/Deactivate the desired samples to be included in the query. For activate/deactivate please, select the row (also select all/deselect all) (optional).

Finally, click in close button to close the query form.

2.3 Piper Plot



Use this command to create automatically Piper Plots for the selected query created previously with the Hydrochemical Spatial Query tool (section 2.2 *Hydrochemical Spatial Query*). This diagram will be created only if the measurements required for the creation of this diagram are available.

| Measurements Query | Parameters | | | | |
|-------------------------------------|-----------------------------|----|----------------|----------------|--|
| only2Points | Available Parameters | | Used Parameter | rs: | |
| AllPoints NorthernPoints | Name | | Name | < Limit Factor | > Limit Factor |
| UserManual | isotopes Water dDeuteri | | magnesium | 1,00 | 1,00 1 1,00 1 1,00 1 1,00 1 1,00 1 |
| | % Sat Oxygen | - | bicarbonate | | 1,00 |
| | 1 - phenyl -1- cyclohexenyl | > | sodium | | 1,00 |
| | 1,1 - Dichloroacetone | < | calcium | 1,00 | 1,00 |
| feasurements Active Measurements | Run Que | ny | | 7 | |
| Active Measurements | TEP 1 | | EP 2 | 7 | |
| Active Measurements | | | EP 2 | Select All | Deselect All |

- Step 1: Choose the Query created previously with the tool shown in section 2.2 Hydrochemical Spatial Query.
- *Step 2*: Choose the limit factor to be applied to the censored values. With this tool the user has the option to substitute the censored values by this factor times the detection limits. The censored values are the concentration of some elements reported as less than, < limit factor, or greater than, > limit factor.

| Measurement | s Query | | | and the second second | | | | | |
|---------------------------|---|----------------------|-------------------------|-----------------------|---------------|--------------|-------------|----------|--------------|
| Sample Quer | 1. C. | Parameters | | | | | | | |
| only2Points | | Available Parameter | \$ | | 3 | Jsed Paramet | ers: | | |
| AllPoints NorthernPoir | nts | | Name | F | 1 | Name | < Limit F | actor >L | imit Factor |
| UserManual | | isotopes Water dD | euteri | | | magnesium | 1.00 | 1.00 | : |
| | | % Sat Oxygen | | | | bicarbonate | 1.00 | 1,00 | |
| | | 1 - phenyl -1- cyclo | hexenvl | | 2 | sodium | 1.00 | 1,00 | |
| | | 1.1 - Dichlorosceto | | | | calcium | 1.00 | 1,00 | |
| | | | - | | | | - | | |
| | | | | - | | | CT | ED. | 0 |
| | | | | Run Query | | | - 31 | EP | 3 |
| Measurement | s | | | | | | - | | |
| Active Measu | rements | | | | | | | | |
| Active | Point | Sample | Sample Date | Campaign | Measurem | ent Date | Parameter | Value | Unit |
| × | P10 | P10_CUP9711-004 | 1997-11-20 00:00:00.000 | Campaign3 | 1997-11-20 00 | :00:00:00 | bicarbonate | 480,7 | ppm |
| × | P10 | P10_CUP9711-004 | 1997-11-20 00:00:00.000 | Campaign3 | 1997-11-20 00 | 00:00:00 | calcium | 175 | ppm |
| | | 004 | 1997-11-20 00:00:00.000 | Campaign3 | 1997-11-20 00 | :00:00:00 | chloride | 252 | ppm |
| S1 | ΓΕΡ | -004 | 1997-11-20 00:00:00.000 | Campaign3 | 1997-11-20 00 | :00:00 | | | 2pm |
| 0 | | -004 | 1997-11-20 00:00:00.000 | Campaign3 | 1997-11-20 00 | :00:00 | TFF | 2 5 | spm |
| ~ | P10 | P10_C0P9711-004 | 1997-11-20 00:00:00.000 | Campaign3 | 1997-11-20 00 | :00:00. | | ~ | xpm |
| × | P10 | P10_CUP0610 | 2006-10-25 00:00:00.000 | Campaign9 | 2006-10-25 00 | ····· | Dicarbonate | 401,38 | mg/l |
| × | P10 | P10_CUP0610 | 2006-10-25 00:00:00.000 | Campaign9 | 2006-10-25 00 | :00:00:00 | calcium | 134,8 | mg/l |
| × | P10 | P10_CUP0610 | 2006-10-25 00:00:00.000 | Campaign9 | 2006-10-25 00 | 00:00:00 | chloride | 193 | mg/l |
| × | P10 | P10_CUP0610 | 2006-10-25 00:00:00.000 | Campaign9 | 2006-10-25 00 | :00:00:00 | magnesium | 28 | mg/l |
| × | PI | P10_CUP0610 | 2006-10-25 00:00:00.000 | Campaign9 | 2006-10-25 00 | :00:00:00 | potassium | 12,2 | mg/l |
| × | 810 | P10_CUP0610 | 2006-10-25 00:00:00.000 | Campaign9 | 2006-10-25 00 | 00:00:00 | sodium | 143,8 | mg/l |
| X | | P10_CUP0610 | 2006-10-25 00:00:00.000 | Campaign9 | 2006-10-25 00 | | sulfates | 165 | mg/l |
| | | 0110-0 | 2001-10-24 00:00:00.000 | Campaign7 | 2001-10-24 00 | 00:00:00 | bicarbonate | 439 | mg/l |
| * | | | | | | | Se | AL | Deselect All |
| Activate | Dea | scovate | | | | | | | |

- Step 3: Run Query.
- *Step 4*: Use this commands to activate or deactivated the selected measurements.
- Step 5: Click Next.

| | | | | | Pij | per Resu | ults | | | | \$ | × |
|---|-------------|----------|--|----------|-----------|-------------|-----------|-------------|-------------|----------------|------------|------|
| 1 | ilt Samples | - | 1. | | | | | | | | | |
| 1 | Point | Campaign | Sample | Date | cium (mec | nesium (m | dium (mec | oride (mex | fates (mec | bonate (m | issium (me | F |
| | P10 | Campaig | P10_CUP | 1997-11 | 8,75 | 3,45455 | 7,6087 | 7,09859 | 4,02083 | 7,88033 | | |
| 2 | P10 | Campaig | P10_CUP | 2006-10 | 6,74 | 2,31405 | 6,25217 | 5,43662 | 3,4375 | 6,58 | 0,31202 | 4 |
| 3 | P11 | Campaig | P11_CAG | 2001-10 | 7,81 | 2,72727 | 9,83043 | 9,91549 | 4,97917 | 7,19672 | 0,741688 | 3 |
| 4 | P3 | Campaig | P3_CCL0 | 2003-01 | 7,32 | 4,42975 | 6,19565 | 4,61972 | 4,91667 | | | TH |
| 5 | P3 | Campaig | P3_CUP0 | 2006-10 | 7,1295 | 3,91653 | 6,42652 | 5,1431 | - | - | 7 | 4 |
| 6 | P6 | Campaig | P6_CUP | 1973-09 | 8,94 | 3,61983 | 4,74783 | 4,69577 | SI | EP | | 5 |
| 7 | 07 | Camnain | 07 CLIDO | 2006-00- | 7 305 | 2 65280 | 7 22475 | 5 83000 | - | | | 4 - |
| | DPI 80 | 3 | | | e: Arial | | 2 | | | one officer [1 | | -1 |
| | X Marker | | | | Line | | | X Leger | ad. | | | |
| | Туре | | set + | | | Contract of | | | | | | |
| | Colorset | | | | Type: | dashed | - | Number of | of columns: | | Automatic | • |
| | | | : | 1 | Colorset: | jet | - | irker scale | | 1,0 🔅 | | 11 |
| | Size | | | | e width: | 0,5 | 1 | | Font size: | 14,00 0 | | - 11 |

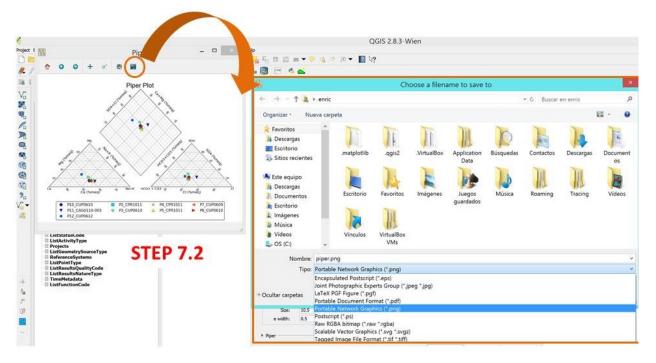
• *Step 6*: Plot configuration. Choose the plot size, title, markerstyle, legend, etc. (optional).

STEP 7.1

| e | | Save file | | | |
|---|--------------------|-------------|-----|----------------------------|-------|
| 🔄 🦻 🔹 🕇 📜 - v | vp2 → UserManualTe | st7112015 ≯ | × 6 | Buscar en UserManualTest71 | 12 P |
| Organizar • Nueva | s carpeta | | | · | 0 |
| 🐉 Sitios recientes | ^ Nombre | ^ | | Fecha de modificaci | Tipo |
| Este equipo Descargas Documentos Escritorio Imágenes Música Videos CoS (C:) | 🗼 bbdd | | | 07/11/2015 3:43 | Carpe |
| 🕵 Red | v c | | | _ | 1 |
| Nombre: u | serManualTest | | | | v |
| Tipo: Lit | preOffice (*.ods) | | | | ¥ |
| | | | | | |

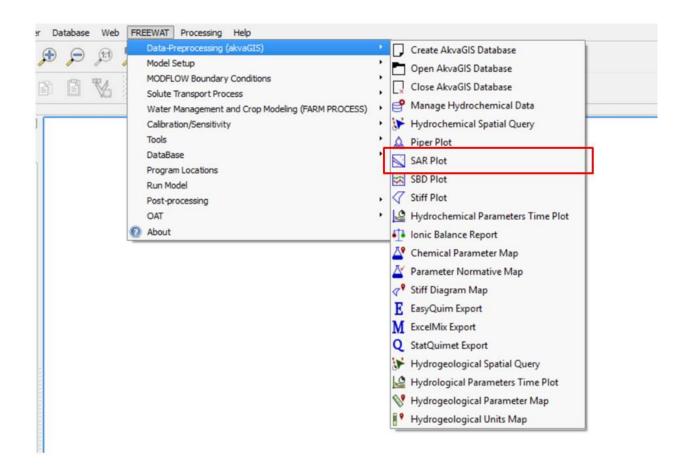
| sesium Lisul | fates (mg/ sulf | ates (ppm soc | fum (mg/lsod | ium (ppm calcium (meg/l) | mag | inesium (mea/l) | sodium (meg/l) | | chloride (meg/l) | sulfates (meg/l) | bicarbonate (meg/l) | valid |
|--------------|-----------------|---------------|--------------|--------------------------|--------|-----------------|----------------|-------------|------------------|------------------|---------------------|-----------|
| 41.8 | | 193 | | 175 | 8.75 | 3.454545455 | 5 | 7.608695652 | 7.098591549 | 4.020833333 | 7.880327869 | VERDADERO |
| | 165 | | 143.8 | | 6.74 | 2.314049583 | 7 | 6.252173913 | 5.436619718 | 3.4375 | 6.58 | VERDADERO |
| | 239 | | 226.1 | | 7.81 | 2.7272727272 | , | 9.830434783 | 9.915492958 | 4.979166667 | 7.196721311 | VERDADERO |
| 53.6 | 236 | | | 142.5 | 7.32 | 4.429752066 | 5 | 6.195652174 | 4.61971831 | 4.9166666667 | | FALSO |
| | 244.9 | | 147.81 | | 7.1295 | 3.916528926 | 5 | 6.426521739 | 5.143098592 | 5.102083333 | 6.64 | VERDADERO |
| 43.8 | | 187.4 | | 109.2 | 8.94 | 3.619834711 | 1 () | 4.747826087 | 4.695774648 | 3.904166667 | 7.180327869 | VERDADERO |
| | 175 | | 168.7 | | 7.395 | 2.652892562 | 2 | 7.334782609 | 5.830985915 | 3.645833333 | 7.12 | VERDADERO |
| 33.1 | | 187.9 | | 199.2 | 5.47 | 2,73553719 |) | 8.660869565 | 6.056338028 | 3.914583333 | | FALSO |

• Step 7.1: Save Piper query results in different formats (e.g. csv, ods, etc.).



• *Step 7.2*: Plot Piper diagram automatically. The plot GUI, enable the user to save the plot in different formats, to pan axes, to zoom, to configure subplots and to save the plot in different formats such as .pdf, .png, .tiff, .svg, etc.

2.4 SAR plot



Use this command to create automatically Salinity Diagrams of the selected query created previously with the Hydrochemical Spatial Query tool (section 2.2 *Hydrochemical Spatial Query*). This diagram will be created only if the measurements required for the creation of this diagram are available.

| Measurements Query Sample Query | Parameters | |
|------------------------------------|-----------------------------|---------------------------------|
| only2Points | Available Parameters | Used Parameters: |
| AllPoints NorthernPoints | Name | Name imit Fa imit |
| UserManual | isotopes Water dDeuteri | magnesium 1,00 🗘 1,0 |
| | % Sat Oxygen | bicarbonate 1,00 0 1,0 |
| | 1 - phenyl -1- cyclohexenyl | sodium 1,00 . 1,0 |
| | 1,1 - Dichloroacetone | < calcium 1,00 1,00 |
| | | |
| STER | P1 STE | EP 2 |
| | P 1 STE | EP 2 Select All Deselect All |

- Step 1: Choose the Query created previously with the tool shown in section 2.2 Hydrochemical Spatial Query.
- *Step 2*: Choose the limit factor to be applied to the censored values. With this tool the user has the option to substitute the censored values by this factor times the detection limits. The censored values are the concentration of some elements reported as less than, < limit factor, or greater than, > limit factor.

| leasurements | s Query | | | | | |
|-----------------------------|--------------------------|--|--|--|--|--|
| Sample Quer | y | Parameters | | | | |
| only2Points | | Available Parameter | \$ | Use | d Parameters: | |
| AllPoints NorthernPoin | its | Nerr | ie 🕒 | | Name imit Fa Lin | nit Fact |
| UserManual | | isotopes Water dD | euteri | sod | lium 1,00 1,0 | 0 |
| | | % Sat Oxygen | | cak | cium 1,00 🕻 1,0 | |
| | | 1 - phenyl -1- cyclo | hexenyl | > EC | 1,00 1,0 | 0 |
| | | 1,1 - Dichloroaceto | ne 🔋 | < ma | gnesium 1,00 1,0 | 0 |
| Active Measur | Point | Sample | Sample Date | Campaign | Measurement Date | |
| | | Samole | Sample Date | Campaign | Measurement Date | |
| × | P10 | P10_CUP9711-004 | 1997-11-20 00:00:00.000 | Campaign3 | 1997-11-20 00:00:00.00 | 0 EC |
| X | | 010 0100711 004 | 1997-11-20 00:00:00.000 | Campaign3 | 1997-11-20 00:00:00.00 | 0 |
| ~ | P10 | P10 C0P9/11-004 | | | 1997-11-20 00:00:00.00 | u car |
| | | 11-004 | 1997-11-20 00:00:00.000 | a | .00 | |
| | ΓEΡ | 11-004 | 1997-11-20 00:00:00.000 1997-11-20 00:00:00.000 | and the second second second | .00 | 0 ma |
| | | 11-004 | | ST | .00 | 0 ma 0 soc |
| ST × | | 4 11-004 | 1997-11-20 00:00:00.000 | ST | =P 5 | 0 ma 0 soc 0 EC |
| ST × | P10 P10 | 4 11-004 11-004 10 P10_CUP0610 P10_CUP0610 | 1997-11-20 00:00:00.000 2006-10-25 00:00:00.000 2006-10-25 00:00:00.000 2006-10-25 00:00:00.000 | Campaigny Campaign9 | .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 | 0 ma 0 soc 0 EC 0 cal 0 ma |
| ST × × | P10 P10 P10 | 4 11-004 10 P10_CUP0610 P10_CUP0610 P10_CUP0610 P10_CUP0610 | 1997-11-20 00:00:00.000 2006-10-25 00:00:00.000 2006-10-25 00:00:00.000 2006-10-25 00:00:00.000 2006-10-25 00:00:00.000 | Campaign9 Campaign9 Campaign9 | .000 .000 .000 .000 .000 .000 .000 .00 | 0 ma 0 soc 0 EC 0 cal 0 ma 0 soc |
| S × × × | P10 P10 P10 P11 | 4 11-004 10 P10_CUP0610 P10_CUP0610 P10_CUP0610 P10_CUP0610 P11_CAG0110-0 | 1997-11-20 00:00:00.000 2006-10-25 00:00:00.000 2006-10-25 00:00:00.000 2006-10-25 00:00:00.000 2006-10-25 00:00:00.000 2006-10-24 00:00:00.000 | Campaign9 Campaign9 Campaign9 Campaign9 Campaign7 | .000 EP5 .001 2006-10-25 00100100.000 2016-10-25 00100100.000 2016-10-25 00100100.000 2016-10-25 00100100.000 | 0 ma 0 soc 0 EC 0 cal 0 ma 0 soc 0 EC |
| S × × × | P10 P10 P10 | 4 11-004 10 10 10 10 10 10 10 10 10 10 | 1997-11-20 00:00:00.000 2006-10-25 00:00:00.000 2006-10-25 00:00:00.000 2006-10-25 00:00:00.000 2006-10-25 00:00:00.000 2001-10-24 00:00:00.000 2001-10-24 00:00:00.000 | Campaign9 Campaign9 Campaign9 Campaign9 Campaign7 Campaign7 | .000 EP5.00:00:00.000 2006-10-25 00:00:00.000 2006-10-25 00:00:00.000 2006-10-25 00:00:00.000 2006-10-24 00:00:00.000 2006-10-24 00:00:00.000 | 0 ma 0 soc 0 EC 0 cal 0 ma 0 soc 0 EC 0 cal |
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- Step 3: Run Query.
- *Step 4*: Use this commands to activate or deactivated the desired measurements.
- Step 5: Click Next.

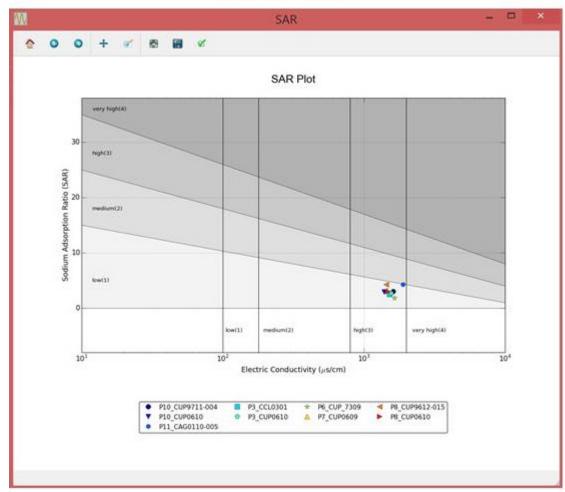
| Point Campaign Sample Date SC (uS/cm hesium (m Jium (mec cium (mec SAR valid P10 Campaig P10_CUP 1997-11 1610 3,45455 7,6087 8,75 3,0801 X P10 Campaig P10_CUP 1997-11 1610 3,45455 7,6087 8,75 3,0801 X P10 Campaig P10_CUP 2006-10 1388 2,31405 6,25217 6,74 2,93849 X P11 Campaig P11_CAG 2001-10 1890 2,72727 9,83043 7,81 4,28276 X P3 Campaig P3_CCL0 2003-01 1516 4,42975 6,19565 7,32 2,55616 X | |
|---|---|
| P10 Campaig P10_CUP 1997-11 1610 3,45455 7,6087 8,75 3,0801 X P10 Campaig P10_CUP 2006-10 1388 2,31405 6,25217 6,74 2,93849 X P11 Campaig P11_CAG 2001-10 1890 2,72727 9,83043 7,81 4,28276 X P3 Campaig P3_CCL0 2003-01 1516 4,42975 6,19565 7,32 2,55616 X | |
| P10 Campaig P10_CUP 2006-10 1388 2,31405 6,25217 6,74 2,93849 X P11 Campaig P11_CAG 2001-10 1890 2,72727 9,83043 7,81 4,28276 X P3 Campaig P3_CCL0 2003-01 1516 4,42975 6,19565 7,32 2,55616 X | |
| P11 Campaig P11_CAG 2001-10 1890 2,72727 9,83043 7,81 4,28276 X P3 Campaig P3_CCL0 2003-01 1516 4,42975 6,19565 7,32 2,55616 X | _ |
| P3 Campaig P3_CCL0 2003-01 1516 4,42975 6,19565 7,32 2,55616 X | |
| P3 Campaig P3_CCL0 2003-01 1516 4,42975 6,19565 7,32 2,55616 X | |
| | |
| P3 Campaig P3_CUP0 2006-10 1556 3,91653 6,42652 7,1295 2,73456 X | |
| P6 Campaig P6_CUP 1973-09 1649 3,61983 4,74783 8,94 | |
| P7 Campaig P7_CUP0 2006-09 1459 2,65289 7,33478 7,395 STEP 6 | 1 |
| P8 Campaig P8_CUP9 1996-12 1434 2,73554 8,6600 5,47 7,27300 | |
| X Marker Type: filled set • Colorset: jet • Size: 10.5 | |
| Size: 10,5 C Font size: 14.00 C | |
| e width: 0,5 | |

• Step 6: Plot configuration. Choose the plot size, title, markerstyle, legend, background colours, etc.

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| |)a Descargas | | | | | | | | | |
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| | * Ocultar carpetas | | | | G | Suardar | Cancel | ar | | |
| 8 | C 0 E F | 6 P | () () | 7 X | | L | м | N | 0 P | Q R |
| Point 2 P10 | Coordinate X Coordinate Y Campaign Sample 432525.545 4589976.41 Campaign3 P10 CUP971 | Date EC (uS/ | (cm) sodium (mg/l) sodium 1610 | n (ppm) calcium (175 | mg/l) calc | tium (ppm) mi 175 | ignesium (ma | | magnesium (sodium (meq ca 3.45454545 7.60869565 | alcium (meq SAR 8.75 3.080097 |
| 2 P10 | 432525.545 4589976.41 Campaign9 P10_CUP971 432525.545 4589976.41 Campaign9 P10_CUP061 | | 1388 143.8 | 113 | 134.8 | 1/5 | 28 | | 2.31404959 6.25217391 | 6.74 2.938492 |
| P11 | 433660 4589040 Campaign7 P11_CAG011 | | 1890 226.1 | | 156.2 | | 33 | | 2.72727273 9.83043478 | 7.81 4.282758 |
| 5 P.3 | 432962.066 4584641.89 Campaign8 P3_CCL0301 | | 1516 | 142.5 | | 146.4 | | 53.6 | 4.42975207 6.19565217 | 7.32 2.556157 |
| 5 P.3 | 432962.066 4584641.89 Campaign9 P3_CUP0610 | 2006-10-24 00:00 | 1556 147.81 | | 142.59 | | 47.39 | | 3.91652893 6.42652174 | 7.1295 2.734562 |
| 9 P6 | 433176.189 4588200.68 Campaign1 P6_CUP_730 | | 1649 | 109.2 | | 178.8 | | 43.8 | 3.61983471 4.74782609 | 8.94 1.894601 |
| 5 P7 | 433630.001 4587270 Campaign9 P7_CUP0609 | | 1459 168.7 | 100000 | 147.9 | | 32.1 | - | 2.65289256 7.33478261 | 7.395 3.272387 |
| 1 P8 1 P8 | 433624.078 4588499.28 Campaign2 PB_CUP9612 433624.078 4588499.28 Campaign9 PB_CUP0610 | | 1434 1476 144.53 | 199.2 | 126.07 | 109.4 | 24.99 | 33.1 | 2.73553719 8.66086957 2.06528926 6.28391304 | 5.47 4.275855 6.3035 3.071947 |

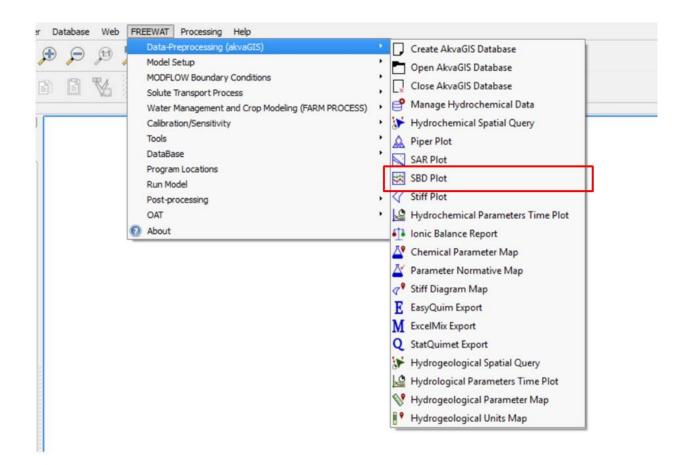
• Step 7.1: Save SAR query results in different formats.

STEP 7.2



• *Step 7.2*: Plot SAR diagram automatically. The plot GUI, enable the user to save the plot in different formats, to pan axes, to zoom, to configure subplots and to save the plot in different formats such as .pdf, .png, .tiff, .svg, etc.

2.5 SBD Plot



Use this command to create automatically Shöeller-Berkaloff diagrams of the selected query created previously with the Hydrochemical Spatial Query tool (section 2.2 *Hydrochemical Spatial Query*). This diagram will be created only if the measurements required for the creation of this diagram are available in the akvaGIS Database.

| 2 | SBD Measure | ments | | | ? > |
|--------------------------------------|-----------------------------|-------|----------------|------------|----------------|
| Measurements Query - Sample Query | Parameters | | | | |
| only2Points AllPoints | Available Parameters | | Used Parameter | rs: | |
| NorthernPoints | Name | | Name | imit Fa | > Limit Factor |
| UserManual | isotopes Water dDeuteri | | sodium | 1,00 | 1.00 |
| | % Sat Oxygen | > | calcium | 1,00 | |
| | 1 - phenyl -1- cyclohexenyl | 1 | sulfates | 1,00 | 1,00 |
| | 1,1 - Dichloroacetone | < | chloride | 1,00 | 1,00 0 |
| leasurements Active Measurements | Run Query | - | / | ~ | |
| Active Measurements | | TEP | 2 | <i>^</i> | |
| Active Measurements | | - | 2 | Select All | Deselect All |

- Step 1: Choose the Query created previously with the tool shown in section 2.2 Hydrochemical Spatial Query.
- *Step 2*: Choose the limit factor to be applied to the censored values. With this tool the user has the option to substitute the censored values by this factor times the detection limits. The censored values are the concentration of some elements reported as less than, < limit factor, or greater than, > limit factor.

| leasurements | Query | | | | | | |
|---------------------------|-----------------|--|--|---|--|------------------|---------------------------------|
| sample Quer | 1 | Parameters | | | | | |
| only2Points | | Available Parameters | | | Used Parameters | s: | |
| AllPoints NorthernPoin | rts . | 1 | Name | - | Name | imit Fe | > Limit Factor |
| UserManual | | isotopes Water dDe | ruteri | | sodium | 1.00 | 1.00 |
| | | % Sat Oxygen | | Dimension of | calcium | - | S |
| | | 1 - phenyl -1- cyclol | hexenyl | > | sulfates | (married | 1,00 1 1,00 1 |
| | | 1,1 - Dichloroacetor | ne (| | chloride | Section and | 1,00 |
| ctive Measur Active | Point | Sample | Sample Date | Campaign | Measurement | Date | Parameter |
| ctive Measur | | | | 1 | 1 | | 1 6 |
| X | Pl0 | | 1997-11-20 00:00:00.000 | | 1997-11-20 00:00: | | bicarbonate |
| Ŷ | P10 | the second s | 1997-11-20 00:00:00:00 | and the second se | 1997-11-20 00:00 | | calcium |
| - | | 1.004 | 1997-11-20 00:00:00.000 | | | | |
| S | ΓΕΡ | 4 1-004 | 1997-11-20 00:00:00.000 | Campaign3 | STE | D | 5 m |
| | | 1-004 | 1997-11-20 00:00:00.000 | Campaign3 | SIE | | 3 |
| | P10 | P10_CUP9711-004 | 1997-11-20 00:00:00.000 | Campaign3 | 1997-11-20 00:00 | 0.000 | surates |
| × | P10 | P10_CUP0610 | 2006-10-25 00:00:00.000 | Campaign9 | 2006-10-25 00:00 | 0.000 | bicarbonate |
| × | | | 2006-10-25 00:00:00.000 | Campaion9 | 2005-10-25 00:00: | 000.000 | calcium |
| ×× | P10 | and the second second second | والمراجع والمراجع والمراجع والمراجع والمراجع والمراجع والمراجع | and the second second second second | المراجع فالمراجع المراجع والمراجع | a second second | |
| ×××× | P10 | P10_CUP0610 | 2006-10-25 00:00:00.000 | Campaign9 | 2006-10-25 00:00 | | chloride |
| ×××× | P10 P10 | P10_CUP0610 P10_CUP0610 | 2006-10-25 00:00:00.000 2006-10-25 00:00:00.000 | Campaign9 Campaign9 | 2006-10-25 00:00: | 00 200 | magnesium |
| **** | P10 P10 | P10_CUP0610 P10_CUP0610 P10_CUP0610 | 2006-10-25 00:00:00.000 2006-10-25 00:00:00.000 2006-10-25 00:00:00.000 | Campaign9 Campaign9 Campaign9 | 2006-10-25 00:00 2006-10-25 00:00 | 00 000 00 000 | magnesium sodium |
| ×××× | P10 P10 | P10_CUP0610 P10_CUP0610 | 2006-10-25 00:00:00.000 2006-10-25 00:00:00.000 | Campaign9 Campaign9 Campaign9 Campaign9 | 2006-10-25 00:00 | 00 000 00 000 | magnesium sodium sulfates |
| **** | P10 P10 P | P10_CUP0610 P10_CUP0610 P10_CUP0610 | 2006-10-25 00:00:00.000 2006-10-25 00:00:00.000 2006-10-25 00:00:00.000 2006-10-25 00:00:00.000 | Campaign9 Campaign9 Campaign9 Campaign9 | 2006-10-25 00:00 2006-10-25 00:00 2006-10-25 00:00 | 00 000 00 000 | magnesium sodium sulfates |

- Step 3: Run Query.
- *Step 4*: Use this commands to activate or deactivated the desired measurements.
- Step 5: Click Next.

| T | Point | Campaign | Sample | Date | C (uS/cm | hesium (m | dium (mec | cium (mec | SAR | valid 🗎 |
|------|----------|---|-----------------------|-----------------------|---------------------|--------------|--|------------------------------|---------|---------------|
| 1 P1 | 10 TO 10 | | | 1997-11 | Construction of the | 3,45455 | 7,6087 | 8,75 | 3,0801 | × |
| 2 P1 | | | | 2006-10 | No. Contraction | 2,31405 | 6,25217 | 6,74 | 2,93849 | x |
| 3 P1 | - | | | 2001-10 | | 2,72727 | 9,83043 | 7,81 | 4,28276 | × |
| 4 P3 | - | | - | 2003-01 | | 4,42975 | 6,19565 | 7,32 | 2,55616 | × |
| 5 P3 | | | | 2006-10 | | 3,91653 | 6,42652 | 7,1295 | 2,73456 | x |
| 6 P6 | | in the second second | | 1973-09 | | 3,61983 | 4,74783 | 8,94 | | |
| 7 P7 | | and the second se | and the second second | 2006-09 | and a Charles | 2,65289 | 7,33478 | 7,395 | ST | EP 6 |
| 8 P8 | | | | 1996-12 | | 2,73554 | 8.650 | 5,47 | 7,21300 | ~ + |
| × | | Type: Colorset: Size: | je 1 | lled set et 0,5 | • | Nur | Legend nber of colu r scale: Font | mns: 4 1,0 size: 14,00 | | • X Automatic |
| SAR | | e width: | 0 | ,5 | Backgrour | nd colors: G | | Save Table | Р | ot Close |

• Step 6: Plot configuration. Choose the plot size, title, marker style, legend, background colours, etc.

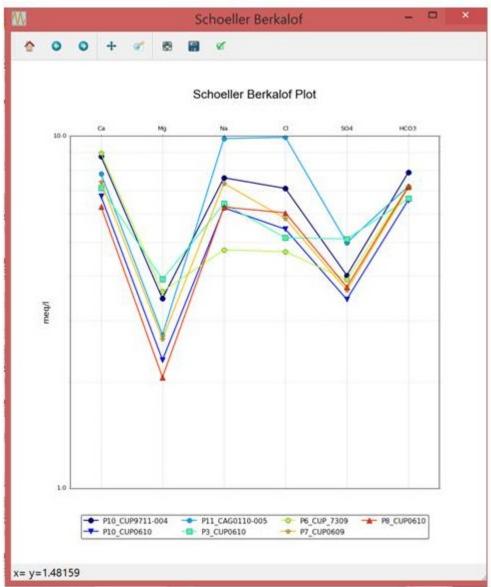
STEP 7.1

| i | | | Save file | | | | × |
|---|--------|-------|---|-----|---|------------------------|------------------------------------|
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| Organizar • Nu | eva ca | rpet | a | | | · | 0 |
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|-----|---------------|---------------------|--------------|---------------|--|--------|--|-----------------------|-------------|-------------------|----------------------|-----------------------|-------------|--|
| may | gnesium (sul | fates (mg/ sulf | ates (ppm so | dium (mg/lsod | fium (ppm calcium (meg/l) | | magnesium (meq/l) | sodium (meq/l) | | chloride (meg/l) | sulfates (meq/l) | bicarbonate (meg/l) | valid | |
| | 41.8 | | 193 | | 175 | 8.75 | 3.454545455 | | 7.608695652 | 7.098591549 | 4.020833333 | 7.88032786 | 9 VERDADERO | |
| | | 165 | | 143.8 | | 6.74 | 2.314049587 | | 6.252173913 | 5.436619718 | 3.4375 | 6.5 | 8 VERDADERO | |
| | | 239 | | 226.1 | | 7.81 | 2.72727272727 | | 9.830434783 | 9.915492958 | 4.9791666667 | 7.19672131 | 1 VERDADERO | |
| | 53.6 | 236 | | | 142.5 | 7.32 | 4.429752066 | | 6.195652174 | 4.61971831 | 4.916666667 | | FALSO | |
| | | 244.9 | | 147.81 | | 7.1295 | 3.916528926 | | 6.426521739 | 5.143098592 | 5.102083333 | 6.6 | 4 VERDADERO | |
| | 43.8 | | 187.4 | | 109.2 | 8.94 | 3.619834711 | | 4.747826087 | 4.695774648 | 3.904166667 | 7.18032786 | 9 VERDADERO | |
| | | 175 | | 168.7 | | 7.395 | 2.652892562 | | 7.334782609 | 5.830985915 | 3.645833333 | 7.1 | 2 VERDADERO | |
| | 33.1 | | 187.9 | | 199.2 | 5.47 | 2.73553719 | | 8.660869565 | 6.056338028 | 3.914583333 | | FALSO | |
| | | | | | | | | | | | | | | |

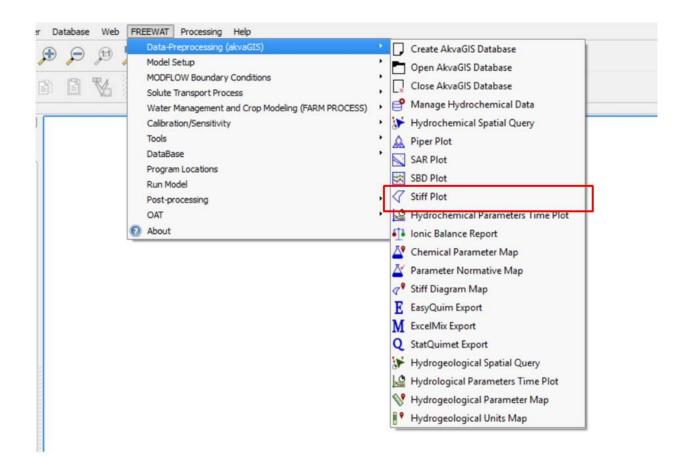
• Step 7.1: Save Shöeller-Berkaloff query results in different formats.

STEP 7.2



• *Step* 7.2: Plot Shoeller-Berkaloff diagrams automatically. The plot GUI, enable the user to save the plot in different formats, to pan axes, to zoom, to configure subplots and to save the plot in different formats such as .pdf, .png, .tiff, .svg, etc.

2.6 Stiff Plot



Use this command to create automatically Stiff plots of the selected query created previously with the Hydrochemical Spatial Query tool (section 2.2 *Hydrochemical Spatial Query*). This diagram will be created only if the measurements required for the creation of this diagram are available.

For obtaining stiff maps, use command Stiff Diagram Map in section 2.11 Stiff Diagram Map.

| t | Stiff N | leasurements | | | ? | × |
|--------------------------------------|-----------------------------|--------------|----------------|------------|-------------------|---|
| feasurements Query - Sample Query | Parameters | | | | | |
| only2Points | Available Parameters | | Used Parameter | rs: | | |
| AllPoints NorthernPoints | Name | - | Name | imit Fa | > Limit Factor | ŀ |
| UserManual | isotopes Water dDeuteri | | magnesium | 1,00 1,0 | 0 | |
| | % Sat Oxygen | | bicarbonate | 1,00 📜 1,0 | 0 : 0 : 0 : | |
| | 1 - phenyl -1- cyclohexenyl | > | sodium | 1,00 📜 1,0 | 0 | |
| | 1,1 - Dichloroacetone | × < | calcium | 1,00 📜 1,0 | 0 | |
| Active Measurement | STEP 1 | STEF | 2 | | | |
| | | | - | | | |
| Activate | Deactivate | | | Select All | Deselect A | l |
| | | | | Next | Close | |

- Step 1: Choose the Query created previously with the tool shown in section 2.1 Manage Hydrochemical Data.
- *Step 2*: Choose the limit factor to be applied to the censored values. With this tool the user has the option to substitute the censored values by this factor times the detection limits. The censored values are the concentration of some elements reported as less than, < limit factor, or greater than, > limit factor.

| leasurement | - 0 | | | | | | | | |
|--|---|-------|---|---|--|---|--|---|--|
| Sample Quer | N. C. 1993 | Y L | Parameters | | | | | | |
| only2Points | ' | | Available Parameters | | | Used Paramete | rs: | | |
| AllPoints NorthernPoir | ote | | | Name | 1 | Name | imit | Fa > Limit | Factor |
| UserManual | | | isotopes Water dDe | | | magnesium | | 1,00 | |
| | | | % Sat Oxygen | and the second se | | bicarbonate | a constant | 1,00 | |
| | | | 1 - phenyl -1- cyclo | hexenvl | > | sodium | palarena ha | 1,00 | |
| | | | 1.1 - Dichloroacetor | | * < | calcium | and the second second | 1,00 | - |
| | | | | | | Hearing | hannes | - 11- C | |
| | | POINT | Sample | Sample Date | Lampaign | measurement D | | Parameter | |
| 1 | | Point | Sample | Sample Date | Campaign | Measurement D | ate | Parameter | Val |
| Active | | | | | | - rearran errrerte er | www. | | - VOL |
| - | | | 1711-004 | 1997-11-20 00:00:00.000 | | 1997-11-20 00:00:00 | | bicarbonate | 480,7 |
| - | ΓE | | 4 711-004 | Contractor of Contractor | Campaign3 | 1997-11-20 00:00:00 1997-1 | 0.000 | bicarbonate | |
| Active S1 | ΓE | | 4 1711-004 | 1997-11-20 00:00:00.000 | Campaign3 Campaign3 | 1997-11-20 00:00:00 | 0.000 | bicarbonate | 480,7 |
| S1 × | PI | P | 4 (711-004 (711-004 | 1997-11-20 00:00:00.000 1997-11-20 00:00:00.000 | Campaign3 Campaign3 Campaign3 | 1997-11-20 00:00:00 1997-1 | 0.000 | bicarbonate | 480,7 175 |
| S 1 × × | | P | 4 1711-004 1711-004 P10_CUP9711-004 | 1997-11-20 00:00:00.000 1997-11-20 00:00:00.000 1997-11-20 00:00:00.000 | Campaign3 Campaign3 Campaign3 Campaign3 | 1997-11-20 00:00:00 1997-1 1997-1 ST | EP | bicarbonate | 480,7 175 252 |
| ST ×××× | P10 | P | 4 1711-004 1711-004 P10_CUP9711-004 P10_CUP9711-004 | 1997-11-20 00:00:00.000 1997-11-20 00:00:00.000 1997-11-20 00:00:00.000 1997-11-20 00:00:00.000 | Campaign3 Campaign3 Campaign3 Campaign3 Campaign3 | 1997-11-20 00:00:00 1997-1 1997-1 1997-1 1997-1 | EP | bicarbonate | 480,7 175 252 41,8 |
| ST × × × | P10 | P | 4 1711-004 1711-004 P10_CUP9711-004 P10_CUP9711-004 | 1997-11-20 00:00:00.000 1997-11-20 00:00:00.000 1997-11-20 00:00:00.000 1997-11-20 00:00:00.000 1997-11-20 00:00:00.000 | Campaign3 Campaign3 Campaign3 Campaign3 Campaign3 Campaign3 | 1997-11-20 00:00:00 1997-1 1997-1 1997-1 1997-1 1997-11-20 00:00:00 | 0.000 EP | bicarbonate 5 sodium | 480,7 175 252 41,8 175 193 |
| S1 × × × × × × × | P10 P10 P10 P10 P10 | P | 4 (711-004 (711-004 P10_CUP9711-004 P10_CUP9711-004 P10_CUP9711-004 P10_CUP0610 | 1997-11-20 00:00:00.000 1997-11-20 00:00:00.000 1997-11-20 00:00:00.000 1997-11-20 00:00:00.000 1997-11-20 00:00:00.000 1997-11-20 00:00:00.000 | Campaign3 Campaign3 Campaign3 Campaign3 Campaign3 Campaign3 Campaign9 | 1997-11-20 00:00:00 1997-1 1997-1 ST 1997-1 1997-1 1997-11-20 00:00:00 1997-11-20 00:00:00 | 0.000 EP 0.000 0.000 | bicarbonate 5 sodium sulfates | 480,7 175 252 41,8 175 193 |
| S1 × × × × × × × × × × | P10 P10 P10 P10 P10 P10 | P | 4 1711-004 1711-004 P10_CUP9711-004 P10_CUP9711-004 P10_CUP9711-004 P10_CUP9610 P10_CUP0610 P10_CUP0610 | 1997-11-20 00:00:00.000 1997-11-20 00:00:00.000 1997-11-20 00:00:00.000 1997-11-20 00:00:00.000 1997-11-20 00:00:00.000 1997-11-20 00:00:00.000 2006-10-25 00:00:00.000 | Campaign3 Campaign3 Campaign3 Campaign3 Campaign3 Campaign3 Campaign9 Campaign9 | 1997-11-20 00:00:00 1997-1 1997-1 ST 1997-1 1997-11-20 00:00:00 1997-11-20 00:00:00 2006-10-25 00:00:00 | 0.000 EP 0.000 0.000 0.000 | sodium sulfates bicarbonate | 480,7 175 252 41,8 175 193 401,38 |
| S1 × × × × × × × | P10 P10 P10 P10 P10 | P | 4 1711-004 1711-004 P10_CUP9711-004 P10_CUP9711-004 P10_CUP9711-004 P10_CUP0610 P10_CUP0610 | 1997-11-20 00:00:00.000 1997-11-20 00:00:00.000 1997-11-20 00:00:00.000 1997-11-20 00:00:00.000 1997-11-20 00:00:00.000 2006-10-25 00:00:00.000 2006-10-25 00:00:00.000 | Campaign3 Campaign3 Campaign3 Campaign3 Campaign3 Campaign9 Campaign9 Campaign9 | 1997-11-20 00:00:00 1997-1 1997-1 1997-1 1997-1 1997-11-20 00:00:00 1997-11-20 00:00:00 2006-10-25 00:00:00 2006-10-25 00:00:00 | 0.000 EP 0.000 0.000 0.000 0.000 | bicarbonate 5 sodium sulfates bicarbonate calcium | 480,7 175 252 41,8 175 193 401,38 134,8 193 28 |
| ST ×××××××××××××××××××××××××××××××××××× | P10 P10 P10 P10 P10 P10 P10 | P | 4 1711-004 (711-004 P10_CUP9711-004 P10_CUP9711-004 P10_CUP9711-004 P10_CUP9610 P10_CUP0610 P10_CUP0610 P10_CUP0610 | 1997-11-20 00:00:00.000 1997-11-20 00:00:00.000 1997-11-20 00:00:00.000 1997-11-20 00:00:00.000 1997-11-20 00:00:00.000 2006-10-25 00:00:00.000 2006-10-25 00:00:00.000 2006-10-25 00:00:00.000 | Campaign3 Campaign3 Campaign3 Campaign3 Campaign3 Campaign9 Campaign9 Campaign9 | 1997-11-20 00:00:00 1997-1 1997-1 1997-1 1997-1 1997-1 1997-11-20 00:00:00 2006-10-25 00:00:00 2006-10-25 00:00:00 2006-10-25 00:00:00 | 0.000 EP 0.000 0.000 0.000 0.000 0.000 | bicarbonate 5 sodium sulfates bicarbonate calcium chloride magnesium | 480,7 175 252 41,8 175 193 401,38 134,8 193 28 ••• |
| S1 × × × × × × × × × × × | P10 P10 P10 P10 P10 P10 P10 | P | 4 1711-004 1711-004 P10_CUP9711-004 P10_CUP9711-004 P10_CUP9711-004 P10_CUP9610 P10_CUP0610 P10_CUP0610 | 1997-11-20 00:00:00.000 1997-11-20 00:00:00.000 1997-11-20 00:00:00.000 1997-11-20 00:00:00.000 1997-11-20 00:00:00.000 2006-10-25 00:00:00.000 2006-10-25 00:00:00.000 2006-10-25 00:00:00.000 | Campaign3 Campaign3 Campaign3 Campaign3 Campaign3 Campaign9 Campaign9 Campaign9 | 1997-11-20 00:00:00 1997-1 1997-1 1997-1 1997-1 1997-1 1997-11-20 00:00:00 2006-10-25 00:00:00 2006-10-25 00:00:00 2006-10-25 00:00:00 | 0.000 EP 0.000 0.000 0.000 0.000 | bicarbonate 5 sodium sulfates bicarbonate calcium chloride magnesium | 480,7 175 252 41,8 175 193 401,3 134,8 193 28 |

- Step 3: Run Query.
- *Step 4*: Use this commands to activate or deactivated the desired measurements.
- *Step 5*: Click Next.

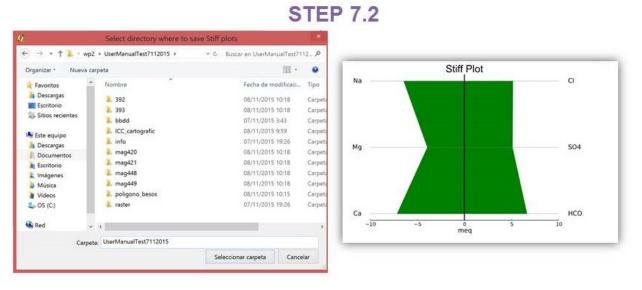
| es | ult Samples | 5 | | | | | | | | |
|----|--------------|------------|-------------------|-------------|-----------|------------|-----------|-----------------------------|------------|----|
| | Point | Campaign | Sample | Date | cium (mec | oride (mer | nesium (m | dium (mec | fates (mec | l, |
| 1 | P10 | Campaig | P10_CUP | 1997-11 | 8,75 | 7,09859 | 3,45455 | 7 6087 | 4 02083 | 7 |
| 2 | P10 | Campaig | P10_CUP | 2006-10 | 6,74 | 5,43662 | 2,3 ST | EP 6 | '5 | 6 |
| 3 | P11 | Campaig | P11_CAG | 2001-10 | 7,81 | 9,91549 | 2,7 | | | 7 |
| 1 | P3 | Campaig | P3_CCL0 | 2003-01 | 7,32 | 4,619 2 | 4,42975 | 6,19565 | 4,91667 | |
| 5 | P3 | Campaig | P3_CUP0 | 2006-10 | 7,1295 | 5,1431 | 3,91653 | 6,42652 | 5,10208 | 6. |
| ī | ~ | | | 1073 00 | 0.00 | 4 (0577 | 2 (1002 | 4 74707 | | 1 |
| | DPI 80 | ¢ | | int type | e: Arial | • nt colo | r: 🔳 🔻 | ont size: 24 | 1,0 🔅 | - |
| | üff | ٥ | | int type | | | r: ■▼ | ont size: 24 | 4,0 🕄 | |
| | tiff Show | atal lines | | | Oth | ers | | | | |
| | üff | | X Horiz X Spec | zontal axis | Oth | | | x range | 4,0 C | |

• *Step 6*: Plot configuration. Choose the plot size, title, Polygon colour, etc. (optional).

| ĩ | | Save f | ile | | |
|--|-------|---------------------------|-----|----------------------------|-------|
| | wp2 | > UserManualTest7112015 > | × 0 | Buscar en UserManualTest71 | 12 P |
| Organizar • Nue | va ca | rpeta | | (III · | |
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| 😽 Este equipo | | 📕 bbdd | | 07/11/2015 3:43 | Carpe |
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| Nombre: | userN | fanualTest | | | ~ |
| | | Office (*.ods) | | | Y |

| | P' | Q | R | S | ī | U | V | W | X | Y |
|----------------|----------------|---------------|--------------|-----------------|------------------|--------------------|---------------|-------------------|-----------------------|-----------|
| ulfates (mg/l) | sulfates (ppm) | sodium (mg/l) | sodium (ppm) | calcium (meq/l) | chloride (meq/l) |) magnesium (meq/l | sodium (meq/I |) sulfates (meq/l |) bicarbonate (meq/I) | valid |
| | 100.2 | | 653.7 | 26.55 | 3.166197183 | 19.00826446 | 28.42173913 | 2.0875 | | FALSO |
| | 101.1 | | 95.9 | 4.23 | 4.312676056 | 1.801652893 | 4.169565217 | 2.10625 | | FALSO |
| 181.43 | | 64.74 | | 4.8965 | 2.652676056 | 4.869421488 | 2.814782609 | 3.779791667 | 4.983606557 | VERDADERO |
| 236 | | | 142.5 | 7.32 | 4.61971831 | 4.429752066 | 6.195652174 | 4.916666667 | | FALSO |

• Step 7.1: Save Stiff query results in different formats.



• Step 7.2: Save Plots. This button creates svg files with the stiff diagram for each point selected during the query.

2.7 Time Plot. Hydrochemical Parameters

| Database Web | FREEWAT Processing Help | |
|--------------|---|---|
| 🕀 🗩 🖻 | Data-Preprocessing (akvaGIS) | Create AkvaGIS Database |
| | Model Setup | Dpen AkvaGIS Database |
| 8 8 8 | MODFLOW Boundary Conditions Solute Transport Process | Close AkvaGIS Database |
| | Water Management and Crop Modeling (FARM PROCESS) | Manage Hydrochemical Data |
| | Calibration/Sensitivity | Hydrochemical Spatial Query |
| | Tools | Piper Plot |
| | DataBase | SAR Plot |
| | Program Locations Run Model | SBD Plot |
| | Post-processing | Stiff Plot |
| | OAT | Hydrochemical Parameters Time Plot |
| | About | 1 Ionic Balance Report |
| | | Chemical Parameter Map |
| | | Parameter Normative Map |
| | | 🛷 🕈 Stiff Diagram Map |
| | | E EasyQuim Export |
| | | M ExcelMix Export |
| | | Q StatQuimet Export |
| | | Hydrogeological Spatial Query |
| | | Hydrological Parameters Time Plot |
| | | 💖 Hydrogeological Parameter Map |
| | | Hydrogeological Units Map |

Use this command to create time plots of the selected query (created previously with the *Hydrochemical Spatial Query tool*, section 2.2) for the selected parameters.

| Measurements | 0.720310.00 | 0 | | 01 | EP | 2 | | | | _ |
|-------------------------------------|------------------|--|-------------------------|------------------------------------|-------------------------------------|----------------------|--|--------|--|--------------------------------------|
| Sample Query only2Points | _ | Parameters Available Pa | £ | | 1 | | | Parame | | - |
| AllPoints | | Available Pa | arameters | 5 | | () | Jsec | Parame | ters: | - |
| NorthernPoint | s | | Name | | - | 1 | | Name | imit Fa | imit F |
| UserManual | | nickel Tota nitrates Nitrates Fie Nitric Oxid | eld | | | > | nitra | ites | 1,00 | 1,00 |
| R | • | | | Run | Query | | | | 1 | |
| Active Measure | emints | | | | Query | ED | 0 | 1 | 7 | |
| Active Measure | Inche | | nple | | ST | | | 1 | Measurer | |
| Active Measure | em ints TEP | | | | ST | | 3 | 1 | Measurer 2006-11-08 0 | |
| Active Measure | Inche | | 611 | : 2006-1. | ST | | | | | 0:00:0 |
| Active Measure Active ST | Inche | | 611 0610 | 2006-1. 2006-10 | ST |):00.000 | componyors | | 2006-11-08 0 | 0:00:C |
| Active Measure Artice ST X | EP | | 611 0610 0110-005 | : 2006-1. 2006-10 2001-10 | ST -25 00:00 -24 00:00 | 0:00.000 0:00.000 | Campaign9 | | 2006-11-08 0 2006-10-25 0 | 0:00:C 0:00:C 0:00:C |
| ST × | ЕР Р11 Р12 | 1 UP0 _CUP1 P11_CAG | 611 0610 0110-005 | : 2006-1. 2006-10 2001-10 | ST -25 00:00 -24 00:00 | 0:00.000 0:00.000 | Campaigns Campaigns Campaigns Campaigns | | 2006-11-08 0 2006-10-25 0 2001-10-24 0 | 0:00:C 0:00:C 0:00:C 0:00:C |

- Step 1: Choose the Query created previously with the tool shown in section 2.2 Hydrochemical Spatial Query.
- *Step 2*: Choose the parameter to be queried for the analysis.
- *Step 3*: Choose the limit factor to be applied to the censored values. With this tool the user has the option to substitute the censored values by this factor times the detection limits. The censored values are the concentration of some elements reported as less than, < limit factor, or greater than, > limit factor.

| ample Query | Que | · | Parameters | STEP | 1 | | | |
|--|-----------------|-----|--|---|------------------------------------|----------------------|------------------------------------|------------------------------------|
| only2Points | | | Available Parame | | Used Para | meters: | | |
| AllPoints NorthernPoin | ts | | Nam | e A | Nar | me | imit Fa | imit F |
| UserManual | | | nickel Total nitrates Nitrates Field | | nitrates | | 1,00 | 1,00 |
| ST | E | P 5 | Nitric Oxide | Run Query | STE | Pe | 5 | (1) |
| | | | | | | | Measurer | |
| easu Active Measur Active | | ts | 5 | Run Query | STE | | | nent |
| easu Active Measur Active | eme | ts | Sample | Run Query Sample Date | Campaign Campaign9 | 2006 | Measurer | ment):00:(|
| east. Active Measur Active X X | eme P1 | ts | Sample P1_CUP0611 P10_CUP0610 | Run Query Sample Date 2006-11-08 00:00:00.000 | Campaign Campaign9 Campaign9 | 2006 | Measurer -11-08 00 | nent):00:():00:(|
| easu Active Measur Active | eme P1 P1 | ts | Sample P1_CUP0611 P10_CUP0610 | Run Query Sample Date 2006-11-08 00:00:00.000 2006-10-25 00:00:00.000 | Campaign Campaign9 Campaign7 | 2006 2006 2001 | Measurer -11-08 00 -10-25 00 | ment):00:():00:():00:(|

- Step 4: Run Query.
- *Step 5*: Use this commands to activate or deactivated the desired measurements.
- Step 6: Click Next.

| su | It Samples | | | | | | | | | |
|-----|--|----------------------------|-------------|--------------|--------------|--------------|-------------|-----------|--------------|----|
| | PointId | Point | oordinate | oordinate | Campaign | Sample | Date | nit | rates (mg/l) | 1 |
| 1 | 1 | P1 | 431168 | | Campaig | | | | | |
| 2 | 2 | P10 | 432526 | 4,58998e | Campaig | P10_CUP | 20 ST | FP | 7 | |
| 3 | 3 | P11 | 433660 | 4,58904e | Campaig | P11_CAG | 20 | | 1 | - |
| Ge | ot configurat neral Plot S Plot Size | | | Title | | | | | | |
| | xels): 860 DPI 80 | Y (pixel | s): 720 🛟 | | Time Plot | • nt color | : | ont size: | 24,0 | |
| 1 | X Marker | | | | × | Legend | | | | - |
| | T | ype: | filled set | • | | | | | × | |
| | Colo | rset: | jet | • | | ber of colur | | • | X Automat | ic |
| | 1 | Size: | 10,5 | 1 | irker | scale: | 1,0 | | | |
| | e w | idth: | 0,5 | | | Font | size: 14,00 | 0 | | |
| Tir | ne Plot | ; | 🗙 Automatic | title Time a | axis format: | year-month | -day | | | _ |
| - | | | | | Г | Save Table | Р | lot | Close | |

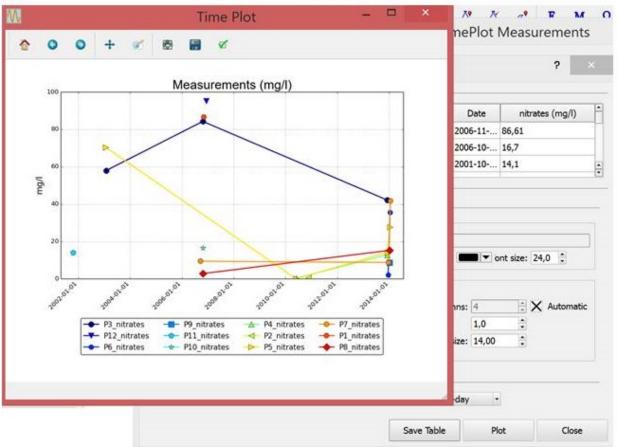
• Step 7: Plot configuration. Choose the plot size, title, markers, time axis format, etc.

STEP 8.1

| Q | | Save file | | | × |
|---|-------------------------|--|--------------------------------|--------------------|-------------|
| \odot \Rightarrow | - 🕆 👗 - wp2 | › UserManualTest7112015 › | ∽ ⊖ Buscar | en UserManualTest | 7112 P |
| Organiza | • Nueva car | peta | | | |
| 🐉 Sitio | s recientes ^ | Nombre | | Fecha de modificac | i., Tipo |
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| Docu Escrit Imág Vide S Vide S OS (0 | enes ca os Ci) | | | | |
| | | < | | | * |
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| * Ocultar ca | rpetas | | | Guardar Car | ncelar |
| E | F | G | н | 1 | 1 |
| mpaign | Sample | Date | silicates (mg/l) | sulfates (mg/l) | nitrates (m |
| mpaign9 | P1_CUP0611 | 2005-11-08 00:00:00.000 | 10.43 | 181.43 | 86.61 |
| mpaign9 | P10_CUP0610 | 2006-10-25 00:00:00.000 | 9.28 | 165 | 16.7 |
| mpaign7 P | 11_CAG0110-0 | 05 2001-10-24 00:00:00.000 | | 239 | 14.1 |
| mpaign9 | P12_CUP0612 | 2006-12-13 00:00:00.000 | 8.96 | 158.22 | 95.08 |
| npaign10 | P2_CPR1011 | 2010-11-24 00:00:00.000 | | 142.45 | 0.6 |
| mpaign8 | P3_CCL0301 | 2003-01-29 00:00:00.000 | | 236 | 57.9 |
| mpaign9 | P3 CUP0610 | 2006-10-24 00:00:00.000 | 8.69 | 244.9 | 84.22 |

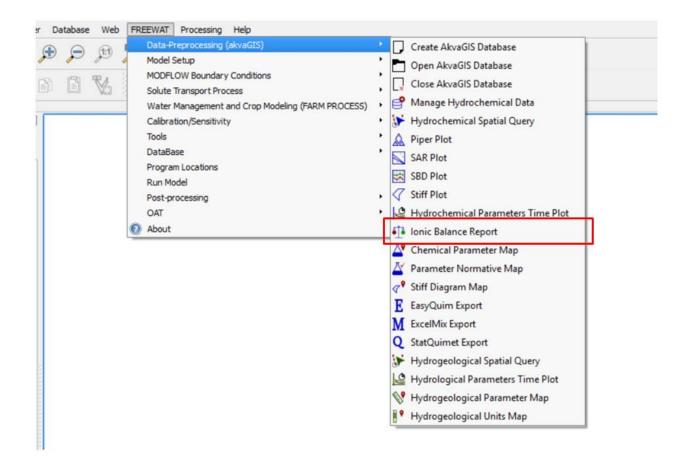
• Step 8.1: Save query results in different formats.

STEP 8.2



• *Step* 8.2: This button creates automatically time plots. Here, the user can edit the plot and save it. The plot GUI, enable the user to save the plot in different formats, to pan axes, to zoom, to configure subplots and to save the plot in different formats such as .pdf, .png, .tiff, .svg, etc.

2.8 Ionic Balance Report



This command was created to calculate ionic balance Report. To date automatically converts all units to meq/l and automatically select the majors ions of the selected sample.

| Measurements Query Sample Query | Parameters | | | | |
|--|-----------------------------|----------------|----------------|----------------|--------------------------------------|
| only2Points AllPoints | Available Parameters | | Used Parameter | s: | |
| NorthernPoints | Name | - | Name | < Limit Factor | > Limit Factor |
| UserManual | isotopes Water dDeuteri | | ammonia | 1,00 🗘 | 1,00 |
| | % Sat Oxygen | | magnesium | | 1,00 ÷ 1,00 ÷ 1,00 ÷ 1,00 ÷ |
| | 1 - phenyl -1- cyclohexenyl | > | bicarbonate | | 1,00 |
| | 1,1 - Dichloroacetone | (<u>*</u>) < | sodium | 1,00 | 1,00 |
| leasurements Active Measurements | | TERNI TERNI | / | / | |
| STREET, STREET | STEP 1 | STE | P 2 | | |
| | STEP 1 Deactivate | STE | P 2 | Select All | Deselect All |

- Step 1: Choose the Query created previously with the tool shown in section 2.2 Hydrochemical Spatial Query.
- *Step 2*: Choose the limit factor to be applied to the censored values. With this tool the user has the option to substitute the censored values by this factor times the detection limits. The censored values are the concentration of some elements reported as less than, < limit factor, or greater than, > limit factor.

| i | | | | Ionic Balanc | e mediaterer | inerine. | | | | |
|----------------------------|----------------|---|---|---|--|---|--|---|--|---------------------|
| Measurement | ts Query | | | | | | | | | |
| Sample Que | γ | Parameters | | | | | | | | |
| only2Points AllPoints | | Available Par | ameters | | | Used Para | ameters: | | | |
| NorthernPoi | | 1 | N | ame | ÷. | Na | me < | Limit Factor | > Limit F | actor a |
| UserManual | | isotopes W | ater dDeute | ri . | | ammonia | 1 | ,00 | 1,00 | 2 |
| | | % Sat Oxy | gen | | 1 | magnesi | um 1 | .00 | 1,00 | |
| | | 1 - phenyl - | 1- cyclohex | enyl | 2 | bicarbon | ate 1 | ,00 | 1,00 | |
| | | 1,1 - Dichlo | roacetone | | - | sodium | 1 | ,00 | 1,00 | |
| leasuremen Active Measu | E. constant | | | | | | | | | |
| Active Measu | urements | | | | | | | | | |
| Active | Point | Samp | | Sample Date | Campaign | Measureme | Measurement Date | | er | Value |
| × | 96 | PE CIP 7 | | 73-09-01 00:00:00.000 | | 1973-09-01 00:0 | 0:00.000 | magnesium | 43, | - |
| CT | EP | 1 1 | | 73-09-01 00:00:00.000 | and the second s | 1973-09-01 00-0 | 0.00 000 | nitrates | 62, | |
| 21 | EF | | participant and participants | 73-09-01 00:00:00.000 | A service and a service of the | 1973-09-0 | TE | DE | 7,2 | |
| | 1.0 | · · | 0.00 | 73-09-01 00:00:00.000 | | | | IF D | 5,4 | |
| | P6 | P6_CUP_7 | 309 193 | 73-09-01 00:00:00.000 | | 1973-09-0 | ****** | | 109 | |
| × | | | | | | | | | 187 | 14 |
| × | P6 | P6_CUP_73 | | 73-09-01 00:00:00.000 | and the same particular from | 1973-09-01 00:0 | Constant of the second | alfates | | |
| ×× | P6 | P6_CUP_73 | 309 193 | 73-09-01 00:00:00.000 | Campaign1 | 1973-09-01 00:0 | 0:00.000 | t tal hardne | ss 626 | |
| ×××× | P6 P6 | P6_CUP_73 P6-2013 | 309 197 201 | 73-09-01 00:00:00.000 13-12-16 00:00:00.000 | Campaign1 Campaign11 | 1973-09-01 00:0 2013-12-16 00:0 | 0:00.000 | t cal hardne n rates | ss 626 2,1 | 85 |
| ××××× | P6 P6 P1 | P6_CUP_73 P6-2013 P6-2014 | 309 197 201 201 | 73-09-01 00:00:00.000 13-12-16 00:00:00.000 14-01-15 00:00:00.000 | Campaign1 Campaign11 Campaign11 | 1973-09-01 00:0 2013-12-16 00:0 2014-01-15 00:0 | 0:00.000 0:00.000 0:00.000 | t cal hardne n rates ni ates | ss 626 2,1 35, | 85 71 |
| × × × × | P6 P6 | P6_CUP_73 P6-2013 P6-2014 P7_CUP060 | 309 197 203 203 203 204 | 73-09-01 00:00:00.000 13-12-16 00:00:00.000 14-01-15 00:00:00.000 16-09-24 00:00:00.000 | Campaign1 Campaign11 Campaign11 Campaign9 | 1973-09-01 00:0 2013-12-16 00:0 2014-01-15 00:0 2006-09-24 00:0 | 0:00.000 0:00.000 0:00.000 0:00.000 | n cal hardne n rates ni ates All linity (Ti | ss 626 2,1 35, AC) 356 | 85 71 5 |
| ***** | | P6_CUP_73 P6-2013 P6-2014 P7_CUP060 P7_CUP060 | 309 197 203 203 203 204 204 204 204 204 204 204 | 73-09-01 00:00:00.000 13-12-16 00:00:00.000 14-01-15 00:00:00.000 06-09-24 00:00:00.000 06-09-24 00:00:00.000 | Campaign1 Campaign11 Campaign11 Campaign9 Campaign9 | 1973-09-01 00:0 2013-12-16 00:0 2014-01-15 00:0 2006-09-24 00:0 2006-09-24 00:0 | 0:00.000 0:00.000 0:00.000 0:00.000 | n rates ni ates Aliulinity (To EC | ss 626 2,1 35, AC) 356 145 | 85 71 5 59 |
| ×××××× | P6 P6 P1 | P6_CUP_73 P6-2013 P6-2014 P7_CUP060 | 309 197 203 203 203 204 204 204 204 204 204 204 | 73-09-01 00:00:00.000 13-12-16 00:00:00.000 14-01-15 00:00:00.000 16-09-24 00:00:00.000 | Campaign1 Campaign11 Campaign11 Campaign9 Campaign9 | 1973-09-01 00:0 2013-12-16 00:0 2014-01-15 00:0 2006-09-24 00:0 | 0:00.000 0:00.000 0:00.000 0:00.000 | n cal hardne n rates ni ates All linity (Ti | ss 626 2,1 35, AC) 356 145 | 85 71 5 |
| ***** | A A A A | P6_CUP_73 P6-2013 P6-2014 P7_CUP060 P7_CUP060 | 309 197 203 203 203 204 204 204 204 204 204 204 | 73-09-01 00:00:00.000 13-12-16 00:00:00.000 14-01-15 00:00:00.000 06-09-24 00:00:00.000 06-09-24 00:00:00.000 | Campaign1 Campaign11 Campaign11 Campaign9 Campaign9 | 1973-09-01 00:0 2013-12-16 00:0 2014-01-15 00:0 2006-09-24 00:0 2006-09-24 00:0 | 0:00.000 0:00.000 0:00.000 0:00.000 | n rates ni ates Aliulinity (To EC | ss 626 2,1 35, AC) 356 145 | 85 71 5 59 |

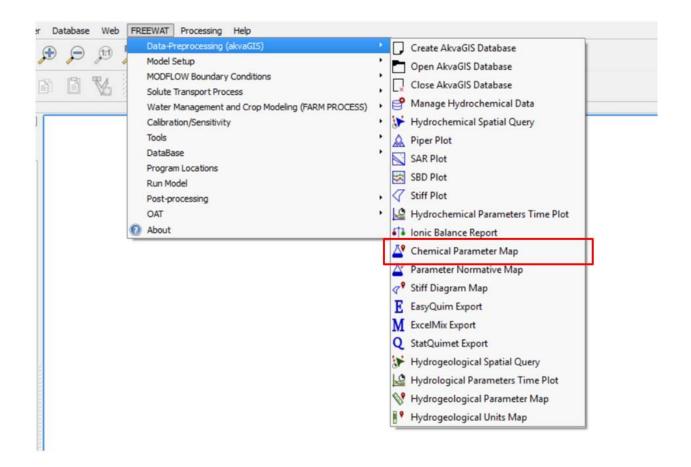
- Step 3: Run Query.
- *Step 4*: Use this commands to activate or deactivated the desired measurements.
- Step 5: Click Next.

| esu | t Samples - | G | Urc | 0.co | AL | nic | a | | | | 0.00 | anno an | |
|-----|-------------|------------|-----------|-----------|------------|-----------|------------|--------|------------------|-------------|------|------------|---|
| | cium (mec | oride (mea | nesium (m | dium (mec | fates (mec | bonate (m | issium (me | nia (i | nitrates (meq/l) | ity (TAC) (| pH | tal hardne | |
| 1 | 8,75 | 7,09859 | 3,45455 | 7,6087 | 4,02083 | 7,88033 | | 2,09 | 0,270968 | 322,959 | 7,17 | 609 | |
| 2 | 6,74 | 5,43662 | 2,31405 | 6,25217 | 3,4375 | 6,58 | 0,31202 | | 0,269355 | 269,672 | | | |
| 3 | 7,81 | 9,91549 | 2,72727 | 9,83043 | 4,97917 | 7,19672 | 0,741688 | 1,41 | 0,227419 | 294,943 | 7,51 | 581 | |
| 4 | 7,32 | 4,61972 | 4,42975 | 6,19565 | 4,91667 | | | | 0,933871 | | 7,2 | 586,2 | |
| 5 | 7,1295 | 5,1431 | 3,91653 | 6,42652 | 5,10208 | 6,64 | 0,0951407 | | 1,35839 | 272,131 | | | |
| 6 | | | 1000 | | | -habit se | | | 0,680323 | | | | |
| 7 | 8,94 | 4,69577 | 3,61983 | 4,74783 | 3,90417 | 7,18033 | 0,163683 | | 1,00806 | 294,27 | 7,28 | 626 | |
| 8 | | | | | | | | | 0,0352419 | 1 | | | |
| 9 | | | | | | | | | 0,575968 | | | | |
| 10 | 7,395 | 5,83099 | 2,65289 | 7,33478 | 3,64583 | 7,12 | 0,225064 | | 0,152581 | 291,803 | | | |
| 11 | | | | | | | | | 0,141645 | | | | |
| 12 | | | | | | | | | 0,671935 | | | | |
| 13 | 5,47 | 6,05634 | 2,73554 | 8,66087 | 3,91458 | | | | 0,280645 | | | 409 | |
| 14 | 6,3035 | 6,0507 | 2,06529 | 6,28391 | 3,72625 | 7,18 | 0,321995 | | 0,0454839 | 294,262 | | | |
| 15 | | | | | | | | | 0,245806 | | | | |
| 16 | | | | | | | | | 0,141468 | | | | |
| | | | | | | | | | | | | | |
| 9 | | | | - | | | | 9 | a a | | 0 | | • |

• *Step 6*: Save query results in different formats with all information related (a) or ionic balance report in ods format (b). It is useful to analyze in detail data stored in the user database necessary to ionic balance calculations and its results.

| | Pint Pint | Coordinate X Coordinate Y Campaign 432525.5449 4589976.413 Campaign9 | Sample Date P10 CUP063 2005-10-25 0 | | common delando de | 193 | 28 | and the second second | 165 | monia (mg pH (u | - | 7.21 | al hardnes# tot | - LINE BUCKEY LINE | 16.7 | 13 |
|----|--|--|--|---|--|---|--|---|---|--|---|--|--|---|--|--|
| P | 11 | | P11 CAG01>2001-10-24 0 | | | 352 | 33 | | 239 | 1.41 | 7.51 | | 581 | | 14,1 | 15 |
| P | 12 | 430858,7211 4582777,016 Campaign9 | P12 CUP06>2006-12-13 0 | 82.96 | | 139.89 | 49.72 | | 158.22 | | | 7,49 | | | 95.08 | 129 |
| P | 2 | 428407,2487 4581490,897 Campaign10 | P2 CPR101>2010-11-24 0 | 146.33 | | 206,41 | 28.01 | | 142,45 | | 7.59 | | | | 0,6 | 130 |
| P | 3 | 432962.0663 4584641.892 Campaign8 | P3 CCL0301 2003-01-29 0 | 1.000 | 142.5 | 164 | | 53.6 | 236 | | 7.2 | | | 586.2 | 57.9 | |
| | 3 | 432962.0663 4584641,892 Campaign9 | P3_CUP0610 2006-10-24 0 | 147,81 | | 182,58 | 47,39 | | 244.9 | | | 7,47 | | | 84,22 | 142 |
| P | 3 | 432962,0663 4584641,892 Campaign11 | P3-2013 2013-12-03 0 | | | | | | | | | | | | 42,18 | |
| P | 4 | 431194,5767 4581402,259 Campaign10 | P4_CPR1013 2010-05-30 0 | 165 | | 201,22 | 28,48 | | 145.55 | | 7,69 | | | | 0,36 | 122 |
| | 4 | 431194,5767 4581402,259 Campaign11 | | | | | | | | | | | | | 12,86 | |
| | 5 | 429844.9611 4581088,809 Campaign8 | | | 152,1 | 305 | | 68,6 | 438,8 | | 7,2 | | | 800,7 | 70,3 | |
| | 5 | 429844,9611 4581088,809 Campaign10 | | | | 183,01 | 26.18 | | 139.14 | | 7,42 | | | | 0,0001 | 117 |
| P | | 429844,9611 4581088,809 Campaign11 | | | | | | | | | | | | | 14,15 | |
| | 5 | 429844,9611 4581088,809 Campaign11 | | | | | | | | | | | | | 27,77 | |
| | 16 | 433176,1889 4588200,677 Campaign11 | | | | | | | | | | | | | 2,185 | |
| | 6 | 433176.1889 4588200,677 Campaign11 | | | | | | | | | | | | | 35,71 | |
| P | | | P7_CUP0609-2006-09-24 0 | | | 207 | 32.1 | | 175 | | | 7,34 | | | 9,46 | 14 |
| P | | 433630.0011 4587270 Campaign11 | | | | | | | | | | | | | 8,782 | |
| p | | 433630.0011 4587270 Campaigh11 | | | | | | | | | | | | | 41,66 | |
| | 8 | 433624.0783 4588499,284 Campaign9 | | | | 214,8 | 24,99 | | 178,86 | | | 7,64 | | | 2,82 | 126 |
| | 18 | 433624.0783 4588499 284 Campaign11 432849 9997 4590000 Campaign11 | | | | | | | | | | | | | 15,24 8 771 | |
| | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | |
| 0 | Catio Ca(m | ns Weight Percentage gl %) Mg(mgl %) Na(mgl %) | Anions K(mgl %) Cl(mgl % | Veight Perce | |)3(mgl %) N(| | Cations me | g Percentag) Mg(megl | | 1%) K(m | | Anions meg Ci(megi %) | | | (megi %NO3(megi %) |
| | Ca(m | | K(mgl %) Cl(mgl 9 | i) 504(| ngl%) HCC | | O3(mgl %) | Ca(megl % |) Mg(megl | %) Na(med | | negi 96) | Cl(megl %) | SO4(meg | 1%) HCO3 | (megi %NO3(megi %) 482567 0,017130745 |
| 4 | Ca(m | gl %) Mg(mgl %) Na(mgl %) | K(mgl %) Cl(mgl 9 9 0,038268507 0,2486 | i) SO4(35703 0,212 | ngl %) HCC 606948 0,5 | 51718895 | 03(mgl %) 0,0215184 | Ca(megl % 0,4315465 |) Mg(meg) 95 0,14816 | %) Na(meg 3237 0,4003 | 81222 0,0 | negl %) 19977948 | Cl(megl %) 0,34576452 | SO4(meg 5 0,218622 | (%) HCO3 2162 0,418 | 482567 0,01713074 |
| 4 | Ca(m 56 0,422 29 0,353 | gl %) Mg(mgl %) Na(mgl %) 2835634 0.08782936 0.45106649 1564258 0.074274139 0.50889038 | K(mgl %) Cl(mgl % 9 0,038268507 0,2486 9 0,065271213 0,3371 | i) SO4(35703 0,212 32459 0,228 | ngl %) HCC 606948 0,5 905277 0,42 | 51718895 20457811 0, | 03(mgl %) 0,0215184 .013504454 | Ca(megl % 0,4315465 0,3699774 | Mg(meg) 95 0,14816 35 0,12919 | %) Na(med 3237 0,4003 7102 0,46565 | 81222 0,0 00019 0,0 | 19977948 35135444 | Cl(megl %) 0,34576452 0,44426639 | SO4(meg 5 0,218622 6 0,223092 | 9%) HCO3 2162 0,418 2935 0,322 | 482567 0,017130745 451082 0,01018958 |
| 00 | Ca(m 56 0,422 29 0,353 64 0,493 | gl %) Mg(mgl %) Na(mgl %) 2835634 0.08782936 0.45106649 1564258 0.074274139 0.50889038 1149104 0.188062637 0.31379075 | K(mgl %) Cl(mgl 9 9 0,038268507 0,2486 9 0,065271213 0,3371 6 0,006997504 0,1816 | SO4(35703 0,212 32459 0,228 30507 0,205 | ngl %) HCC 606948 0,5 905277 0,42 429829 0,48 | 51718895 20457811 0, 39489606 0, | 03(mgl %) 0,0215184 013504454 123450058 | Ca(megl % 0,4315465 0,3699774 0,4554266 | Mg(meg) 95 0.14816 35 0.12919 87 0.28823 | %) Na(meg 3237 0,4003 7102 0,46569 8684 0,25301 | 81222 0,0 90019 0,0 15673 0,0 | negl %) 19977948 35135444 03318956 | Cl(megl %) 0,34576452 0,44426639 0,26357067 | SO4(meg 5 0,218622 6 0,223092 6 0,220474 | (%) HCO3 2162 0,418 2935 0,322 4779 0,413 | 482567 0,017130748 451082 0,01018958 380788 0,10257375 |
| 4 | Ca(m 56 0,422 29 0,353 64 0,493 51 0,400 | gl %) Mg(mgl %) Na(mgl %) 2835634 0.06782936 0.45106649 1564258 0.074274139 0.50889038 1149104 0.188062637 0.31379075 0453529 0.085833359 0.44841111 | K(mgl %) Cl(mgl 9 9 0,038268507 0,2486 9 0,065271213 0,3371 6 0,006997504 0,1816 8 0,065301995 0,2634 | SO4() SO3 0,212 SO40 SO40 | ngl %) HCC 606948 0,5 905277 0,42 429829 0,48 183791 0,55 | 51718895 20457811 0, 39489606 0, 53913121 0, | 03(mgl %) 0,0215184 013504454 123450058 ,000765902 | Ca(megi % 0,4315465 0,3699774 0,4554266 0,4146975 | Mg(meg) 95 0.14816 35 0.12919 87 0.28823 11 0.14691 | %) Na(med 3237 0,4003 7102 0,46565 8684 0,25301 9701 0,40375 | 81222 0,0 90019 0,0 15673 0,0 92116 0,0 | egl %) 19977948 35135444 03318956 34590671 | Cl(megl %) 0,34576452 0,44426639 0,26357067 0,3655602 | SO4(meg 5 0,21862) 6 0,22309 6 0,220474 1 0,18658 | 96) HCO3 2162 0,418 2935 0,322 4779 0,413 5441 0,447 | 482567 0,017130745 451082 0,01018958 380788 0,102573756 245911 0,000608438 |
| 4 | Ca(m 56 0,422 29 0,353 64 0,493 51 0,400 02 0,413 | gl %) Mg(mgl %) Na(mgl %) 2835634 0.08782936 0.45106649 1564258 0.074274139 0.50889038 1149104 0.188052637 0.31379075 0455252 0.085833355 0.44841111 7528037 0.138766068 0.43281309 | K(mgl %) Cl(mgl %) 9 0,038268507 0,2486 9 0,065271213 0,3371 6 0,006997504 0,1816 8 0,065301995 0,2634 5 0,0108928 0,1991 | i) 504(35703 0,212 32459 0,228 30507 0,208 33067 0,18 52249 0,267 | ngl %) HCC 606948 0.5 905277 0.42 429829 0.48 183791 0.55 142265 0.44 | 51718895 20457811 0, 39489606 0, 53913121 0, 11826472 0, | 03(mgl %) 0,0215184 013504454 123450058 000765902 091869014 | Ca(meg) % 0,4315465 0,3699774 0,4554266 0,4146975 0,4058302 | Mg(meg) 95 0.14816 35 0.12919 87 0.28823 11 0.14691 18 0.22293 | %) Na(meg 3237 0,4003 7102 0,46569 8684 0,25301 9701 0,40379 9307 0,36581 | 81222 0.0 0019 0.0 15673 0.0 2116 0.0 14814 0.0 | egl %) 19977948 35135444 03318956 34590671 05415661 | Cl(megl %) 0,34576452 0,44426639 0,26357067 0,3655602 0,28191296 | SO4(meg 5 0,21862) 6 0,22309 6 0,220474 1 0,186585 3 0,279664 | 1%) HCO3 2162 0.418 2935 0.322 4779 0.413 5441 0.447 4759 0.363 | 482567 0,017130745 451082 0,01018958 380788 0,102573756 245911 0,000608438 963871 0,074458408 |
| 4 | Ca(m 56 0,422 29 0,353 64 0,493 51 0,400 02 0,413 | gl %) Mg(mgl %) Na(mgl %) 2835634 0.06782936 0.45106649 1564258 0.074274139 0.50889038 1149104 0.188062637 0.31379075 0453529 0.085833359 0.44841111 | K(mgl %) Cl(mgl %) 9 0,038268507 0,2486 9 0,065271213 0,3371 6 0,006997504 0,1816 8 0,065301995 0,2634 5 0,0108928 0,1991 | i) 504(35703 0,212 32459 0,228 30507 0,208 33067 0,18 52249 0,267 | ngl %) HCC 606948 0.5 905277 0.42 429829 0.48 183791 0.55 142265 0.44 | 51718895 20457811 0, 39489606 0, 53913121 0, 11826472 0, | 03(mgl %) 0,0215184 013504454 123450058 000765902 091869014 | Ca(meg) % 0,4315465 0,3699774 0,4554266 0,4146975 0,4058302 | Mg(meg) 95 0.14816 35 0.12919 87 0.28823 11 0.14691 18 0.22293 | %) Na(meg 3237 0,4003 7102 0,46569 8684 0,25301 9701 0,40379 9307 0,36581 | 81222 0.0 0019 0.0 15673 0.0 2116 0.0 14814 0.0 | egl %) 19977948 35135444 03318956 34590671 05415661 | Cl(megl %) 0,34576452 0,44426639 0,26357067 0,3655602 0,28191296 | SO4(meg 5 0,21862) 6 0,22309 6 0,220474 1 0,186585 3 0,279664 | 1%) HCO3 2162 0.418 2935 0.322 4779 0.413 5441 0.447 4759 0.363 | 482567 0,017130745 451082 0,01018958 380788 0,102573756 245911 0,000608438 963871 0,074458408 |
| 4 | Ca(m 56 0,422 29 0,352 64 0,492 51 0,400 02 0,412 56 0,368 | gl %) Mg(mgl %) Na(mgl %) 2835634 0.08782936 0.45106649 1564258 0.074274139 0.50889038 1149104 0.188052637 0.31379075 0455252 0.085833355 0.44841111 7528037 0.138766068 0.43281309 | K(mgl %) Cl(mgl %) 9 0.038268507 0.2486 9 0.065271213 0.3371 6 0.006997504 0.1816 0.065301995 0.2634 5 0.0106928 0.1991 1 0.048675367 0.2633 | SO4(S703 0,212 S2459 0,228 S0507 0,205 S3067 0,18 S2249 0,267 76963 0,190 | ng %) HCC 606948 0.5 905277 0.42 429829 0.48 183791 0.56 142265 0.44 610471 0.54 | 51718895 20457811 0, 39489606 0, 33913121 0, 41826472 0, 45641361 0, | 03(mgl %) 0.0215184 013504454 123450058 .000765902 .091869014 .000471204 | Ca(med) % 0,4315465 0,3699774 0,4554266 0,4146975 0,4058302 0,3805921 | Mg(meg) 95 0.14816 35 0.12919 87 0.28823 11 0.14691 18 0.22293 55 0.14666 | %) Na(meg 3237 0,4003 7102 0,46565 8684 0,25301 9701 0,40375 9307 0,36581 1262 0,44700 | 81222 0.0 0019 0.0 15673 0.0 2116 0.0 14814 0.0 29663 0. | egl %) 19977948 35135444 03318956 34590671 05415661 02573692 | Cl(megl %) 0.34576452 0.44426639 0.26357067 0.3655602 0.28191296 0.3647423 | SO4(meg 5 0,218622 6 0,223092 6 0,220474 1 0,186585 3 0,27966- 1 0,195125 | 1%) HCO3 2162 0.418 2935 0.322 4779 0.413 5441 0.447 4759 0.363 5633 0.439 | 482567 0,017130745 451082 0,01018958 380788 0,102573756 245911 0,000608438 963871 0,074458400 758416 0,00037364 |

2.9 Chemical Parameter Map



Use this command to obtain the minimum, maximum and average for each selected parameter, for the selected query and to represent these values in a map.

| ABOURADA | Ouen | | | | | | | |
|------------------------------|----------------------------|---|---|---|---|--|--|---|
| leasurements Sample Query | | Parameters | S | TEP | 2 | | | _ |
| only2Points | | Available Parameter | | | Jsed Parameters: | | | |
| AllPoints NorthernPoint | ts | | Name | | Name | < Limit Factor | > Limit Fact | or |
| UserManual | | nickel | | | nitrates | 1,00 | 1,00 | - |
| | | nickel SQ | | | 5 | | | |
| | | nickel Total | | | > | | | |
| | | nitrates | | | < | | | |
| | | | | • | | | | _ |
| | | | | | - | | | |
| | 0 | | | Run Query | | 1 | | |
| easurements | | | | | | | | _ |
| Active Measur | er ents | | | | | | | |
| Active | Poin | t Sample | Sample Date | Campaign | Measurement Date | Parameter | Value | |
| × | P10 | P10_CUP9711-004 | 1997-11-20 00:00:00.000 | Campaign3 | 1997-11-20 00:00:00.00 | nitrates | 16,8 | I |
| | P10 | P10 CUP0610 | 2006-10-25 00:00:00.000 | Campaign9 | 2006-10-25 00:00:00.00 | nitrates | 16,7 | |
| × | | 110_0010010 | | | | | | |
| × | | | 2001-10-24 00:00:00.000 | Car |); 0.000 | nitrates | 14,1 | ŧ |
| V | | Dr. C.C. 10-005 | 2001-10-24 00:00:00.000 2003-01-29 00:00:00.000 | Car | | nitrates nitrates | 14,1 57,9 | 1 |
| V | - Contract of the | Dr. C.C. 10-005 | An and a second s | |); 0.000 | | | 1 |
| V | | P 1 1 | 2003-01-29 00:00:00.000 | Car Car Car | EP 3 100.000 | nitrates | 57,9 | 2 2 2 2 |
| S × | TE | P 1 ¹ | 2003-01-29 00:00:00.000 2006-10-24 00:00:00.000 | Car Car Car Campaign11 | EP 3 100.000 | nitrates nitrates | 57,9 84,22 | 1 |
| S | TE P3 | P1 1 P3-2013 | 2003-01-29 00:00:00.000 2006-10-24 00:00:00.000 2013-12-03 00:00:00.000 | Car Car Car Campaign11 Campaign1 | EP3 2013-12-03 00:00:00.000 | nitrates nitrates nitrates | 57,9 84,22 42,18 | 1 1 1 1 1 |
| S × | P3 P6 | P 1 1 P ¹ 0 P ³⁻²⁰¹⁵ P6_CUP_7309 | 2003-01-29 00:00:00.000 2006-10-24 00:00:00.000 2013-12-03 00:00:00.000 1973-09-01 00:00:00.000 | Car Car Car Campaign11 Campaign1 Campaign11 | EP3 2000 2013-12-03 00:00:00.000 1973-09-01 00:00:00.000 | nitrates nitrates nitrates nitrates | 57,9 84,22 42,18 62,5 | 1 1 1 1 1 1 |
| S ××× | P3 P6 P6 | P 1 1 P3-2013 P6_CUP_7309 P6-2013 | 2003-01-29 00:00:00.000 2006-10-24 00:00:00.000 2013-12-03 00:00:00.000 1973-09-01 00:00:00.000 2013-12-16 00:00:00.000 | Car Car Car Campaign11 Campaign11 Campaign11 Campaign11 | EP3 (0.000 (0.000) (0. | nitrates nitrates nitrates nitrates nitrates | 57,9 84,22 42,18 62,5 2,185 | 2 2 2 2 2 2 2 2 |
| > S | P5 P6 P6 | P 1 1 P 2013 P6_CUP_7309 P6-2013 P6-2014 | 2003-01-29 00:00:00.000 2006-10-24 00:00:00.000 2013-12-03 00:00:00.000 1973-09-01 00:00:00.000 2013-12-16 00:00:00.000 2014-01-15 00:00:00.000 | Car Car Car Campaign11 Campaign11 Campaign11 Campaign11 | EP3 (0.000 (0.000) (0. | nitrates nitrates nitrates nitrates nitrates nitrates | 57,9 84,22 42,18 62,5 2,185 35,71 9,46 | 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 |
| , S | P3 P6 P6 P6 P7 | P 1 1 P 2013 P6_CUP_7309 P6-2013 P6-2014 | 2003-01-29 00:00:00.000 2006-10-24 00:00:00.000 2013-12-03 00:00:00.000 1973-09-01 00:00:00.000 2013-12-16 00:00:00.000 2014-01-15 00:00:00.000 | Car Car Car Campaign11 Campaign11 Campaign11 Campaign11 | EP3 (0.000 (0.000) (0. | nitrates nitrates nitrates nitrates nitrates nitrates | 57,9 84,22 42,18 62,5 2,185 35,71 9,46 | Contract . |

- Step 1: Choose the Query created previously with the tool shown in section 2.2 Hydrochemical Spatial Query.
- *Step 2*: Choose the parameter to be queried for the analysis.
- *Step 3*: Choose the limit factor to be applied to the censored values. With this tool the user has the option to substitute the censored values by this factor times the detection limits. The censored values are the concentration of some elements reported as less than, < limit factor, or greater than, > limit factor.

| Sample Query | Query | Parameters | OTED | | |
|--|--|--|--|--|---|
| only2Points | | Available Parameters | STEP | 4 Used Para | meters: |
| AllPoints NorthernPoints UserManual | | Name | - | Nar | ne imit Fa imit F |
| | | nickel nickel SQ nickel Total nitrates | , , , | nitrates | 1,00 1,00 |
| | | | | | |
| Active Measure | ements Point | Sample | Sample Date | Campaign | Measurement |
| Active \ | 1 | Sample P10 CUP9711-004 | Sample Date | Campaign Campaign3 | |
| Active X | Point P10 | P10_CUP9711-004 | Sample Date 1997-11-20 00:00:00.000 2006-10-25 00:00:00.000 | Campaign3 | Measurement 1997-11-20 00:00:0 |
| Active X | Point | P10_CUP9711-004 | 1997-11-20 00:00:00.000 2006-10-25 00:00:00.000 | Campaign3 | 1997-11-20 00:00:0 |
| Active X | Point P10 | P10_CUP9711-004 | 1997-11-20 00:00:00.000 | Campaign3 C STE | 1997-11-20 00:00:0 |
| Active X ST | Point P10 | P10_CUP9711-004 0_CUP0610 1_CAG0110-005 | 1997-11-20 00:00:00.000 2006-10-25 00:00:00.000 2001-10-24 00:00:00.000 | Campaign3 C C STE | 1997-11-20 00:00:0 25 00:00:0 P 6 24 00:00:0 |
| Active X ST | Point P10 | P10_CUP9711-004 0_CUP0610 1_CAG0110-005 P3_CCL0301 | 1997-11-20 00:00:00.000 2006-10-25 00:00:00.000 2001-10-24 00:00:00.000 2003-01-29 00:00:00.000 | Campaign3 C C C C C C C C C C C C C C C C C C C | 1997-11-20 00:00:0 25 00:00:0 24 00:00:0 29 00:00:0 |
| Active X ST | Point P10 EP (P3 P2 | P10_CUP9711-004 0_CUP0610 1_CAG0110-005 P3_CCL0301 P3_CUP0610 | 1997-11-20 00:00:00.000 2006-10-25 00:00:00.000 2001-10-24 00:00:00.000 2003-01-29 00:00:00.000 2006-10-24 00:00:00.000 | Campaign3 C C C C C C C C C C C C C C C C C C C | 1997-11-20 00:00:0 P 6 25 00:00:0 24 00:00:0 29 00:00:0 2006-10-24 00:00:0 |
| Active X ST X X X X X | Point P10 EP (P2 P2 P2 | P10_CUP9711-004 0_CUP0610 1_CAG0110-005 P3_CCL0301 P3_CUP0610 P3-2013 | 1997-11-20 00:00:00.000 2006-10-25 00:00:00.000 2001-10-24 00:00:00.000 2003-01-29 00:00:00.000 2006-10-24 00:00:00.000 2013-12-03 00:00:00.000 | Campaign3 C C STE C Campaign9 Campaign11 Campaign1 | 1997-11-20 00:00:0 25 00:00:0 24 00:00:0 29 00:00:0 2006-10-24 00:00:0 2013-12-03 00:00:0 |
| Active X ST | Point P10 EP (P1 P2 P2 P2 P2 P2 | P10_CUP9711-004 0_CUP0610 1_CAG0110-005 P3_CCL0301 P3_CUP0610 P3-2013 P6_CUP_7309 | 1997-11-20 00:00:00.000 2006-10-25 00:00:00.000 2001-10-24 00:00:00.000 2003-01-29 00:00:00.000 2006-10-24 00:00:00.000 2013-12-03 00:00:00.000 1973-09-01 00:00:00.000 | Campaign3 C C C Campaign9 Campaign11 Campaign11 Campaign11 | 1997-11-20 00:00:0 25 00:00:0 24 00:00:0 29 00:00:0 2006-10-24 00:00:0 2013-12-03 00:00:0 1973-09-01 00:00:0 |
| Active X ST X X X X X | Point P10 EP (P1 P2 P2 P2 P2 P2 | P10_CUP9711-004 0_CUP0610 1_CAG0110-005 P3_CCL0301 P3_CUP0610 P3-2013 P6_CUP_7309 P6-2013 | 1997-11-20 00:00:00.000 2006-10-25 00:00:00.000 2001-10-24 00:00:00.000 2003-01-29 00:00:00.000 2006-10-24 00:00:00.000 2013-12-03 00:00:00.000 1973-09-01 00:00:00.000 2013-12-16 00:00:00.000 | Campaign3 C C STE C Campaign9 Campaign11 Campaign11 Campaign11 Campaign11 | 1997-11-20 00:00:0 P 6 25 00:00:0 24 00:00:0 2006-10-24 00:00:0 2013-12-03 00:00:0 1973-09-01 00:00:0 2013-12-16 00:00:0 |

- Step 4: Run Query.
- *Step 5*: Use this commands to activate or deactivated the desired measurements.
- Step 6: Click Next.

| | PointId | Point | oordinate | oordinate | Campaign | Sample | Date | :rates (mg | rates (ppr | F |
|----|--------------------------|-------|------------|-----------|----------|------------|---------|------------|------------|---|
| 1 | 2 | P10 | 432526 | 4,58998e | Campaig | P10_CUP | 1997-11 | | 16,8 | |
| 2 | 2 | P10 | 432526 | 4,58998e | Campaig | P10_CUP | 2006-10 | 16,7 | | |
| 3 | 3 | P11 | 433660 | 4,58904e | Campaig | P11_CAG | 2001-10 | 14,1 | | |
| 4 | 6 | P3 | 432962 | 4,58464e | Campaig | P3_CCL0 | 2003-01 | 57,9 | | |
| 5 | 6 | P3 | 432962 | 4,58464e | Campaig | P3_CUP0 | 2006-10 | 84,22 | | |
| 5 | 6 | P3 | 432962 | 4,58464e | Campaig | P3-2013 | 2013-12 | 42,18 | | |
| 7 | 9 | P6 | 433176 | 4,5882e | Campaig | P6_CUP | 1973-09 | | 62,5 | |
| 8 | 9 | P6 | 433176 | 4,5882e | Campaig | P6-2013 | 2013-12 | 2,185 | | |
| 9 | 9 | P6 | 433176 | 4,5882e | Campaig | P6-2014 | 2014-01 | OTE | | |
| 10 | 10 | P7 | 433630 | 4,58727e | Campaig | P7_CUP0 | 2006-09 | STE | P / | |
| 11 | 10 | P7 | 433630 | 4,58727e | Campaig | P7-2013 | 2.13-12 | 8,782 | | - |
| 12 | 10 | P7 | 433630 | 4,58727e | Campaig | P7-201 | 2014-01 | 41,66 | | |
| 13 | 11 | P8 | 433624 | 4,5885e | Campaig. | 8_CUP9 | 1996-12 | | 17,4 | |
| 14 | 11 | P8 | 433624 | 4.5885e | Cam | P8 CUP0 | 2006-10 | 2.82 | | ÷ |
| | ip settings ue to use | 0 | Earliest 🔘 | Latest 🌒 | | Minimum | Maxim | _ | | - |
| | | | | | | Save Table | Ma | ар | Close | |

• *Step* 7: Map settings. Select the value to use in the map. Statistical calculations can be used to be represented in the maps such as average value, mean, minimum, etc.

STEP 8.1

| a | | Save file | | | × |
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| * Ocultar | carpetas | | | Guardar Can | celar |
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| mpaign | Sample | Date | silicates (mg/l) | sulfates (mg/l) | nitrates (m |
| npaign9 | P1_CUP0611 | 2005-11-08 00:00:00.000 | 10.43 | 181.43 | 86.61 |
| npaign9 | P10_CUP0610 | 2006-10-25 00:00:00.000 | 9.28 | 165 | 16.7 |
| npaign7 | P11_CAG0110-005 | 2001-10-24 00:00:00.000 | | 239 | 14.1 |
| npaign9 | P12_CUP0612 | 2006-12-13 00:00:00.000 | 8.96 | 158.22 | 95.08 |
| paign10 | P2_CPR1011 | 2010-11-24 00:00:00.000 | | 142.45 | 0.6 |
| npaign8 | P3_CCL0301 | 2003-01-29 00:00:00.000 | | 236 | 57.9 |
| npaign9 | P3 CUP0610 | 2006-10-24 00:00:00.000 | 8.69 | 244.9 | 84.22 |

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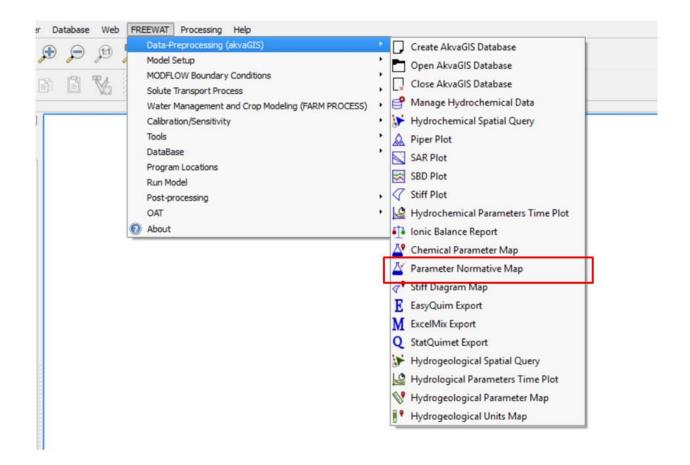
• *Step 8.1*: Save query results in different formats.

🔏 QGIS 2.18.3

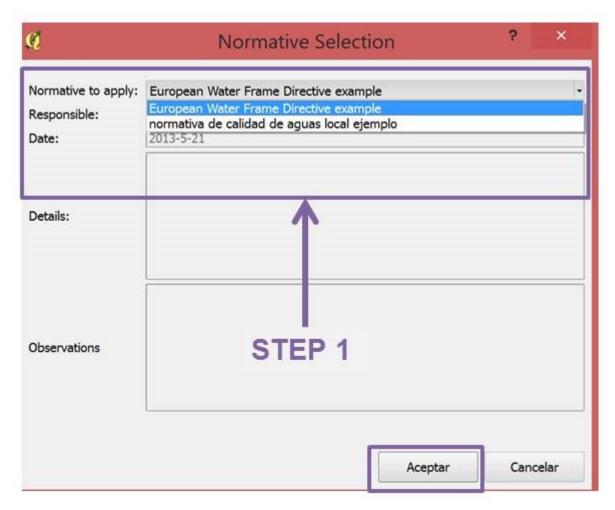
| Processes Responsible/Parties Processes Responsible/Parties Processes Responsible/Parties Processes Responsible/Parties Processes Responsible/Parties Processes Responsible/Parties Processes Responsible/Parties Catalons ListStatusCode List | Panel del explorador (8)X | ©P10 |
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• *Step 8.2*: This button creates automatically the map with the selected values.

2.10 Parameter Normative Map



This command enables the user to obtain thematic maps for the queried parameters, classified according to the threshold approach established by a given guideline (e.g. Water Framework Directive).



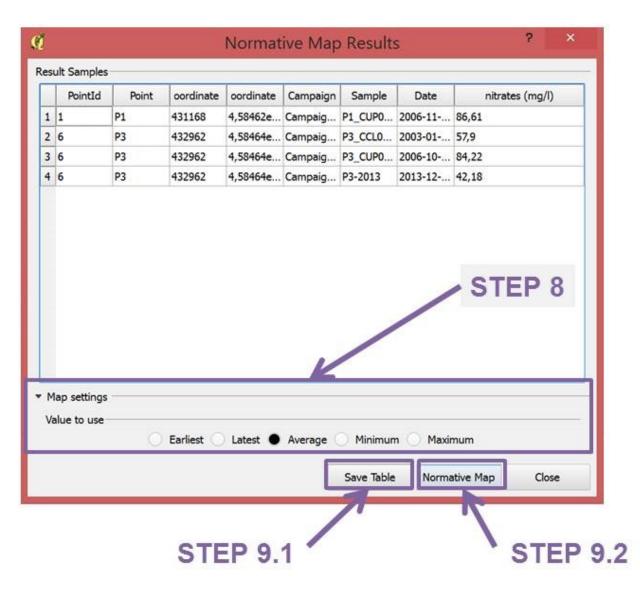
• *Step 1*: Choose the Normative to be applied (The different normatives and the threshold values must to be entered in the database, in the tables *Normatives* and *Normatives Parameters*) and click accept. For further information about the contents of this table, please see the *Database Documentation Section*.

| ĩ | | Normative Map Measurements | | | ? > |
|-----------------------------|---|---|---------------|----------------|----------------|
| Measurements Query | 19 | STEP 3 | | | |
| Sample Query only2Points | Parameters Available Parameters in "European | Water Frame Directive example' Normative: | Used Paramete | rs: | |
| AllPoints NorthernPoints | | Name | Name | | > Limit Factor |
| UserManual | | | nitrates | | 1,00 |
| | | | | | |
| | | | ¢ | | |
| R | 1 | Run Query | | 7 | |
| | | | | | |
| leasurements | | | | | |
| | | | / | | |
| Active Measurements | STEP 2 | STEP 4 | / | 2 | |
| Active Measurements | STEP 2 | STEP 4 | | 2 ⁰ | |
| Active Measurements | STEP 2 | STEP 4 | | | |
| | STEP 2 | STEP 4 | | Select All | Deselect All |

- Step 2: Choose the Query created previously with the tool shown in section 2.2 Hydrochemical Spatial Query.
- *Step 3*: Choose the parameter to be queried for the analysis.
- *Step 4*: Choose the limit factor to be applied to the censored values. With this tool the user has the option to substitute the censored values by this factor times the detection limits. The censored values are the concentration of some elements reported as less than, < limit factor, or greater than, > limit factor.

| x > Limit F | Facto | |
|---------------------------|---|--|
| | Facto | |
| | Facto | |
| 1 00 | x > Limit Factor | |
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- *Step 5*: Run Query.
- *Step 6*: Use this commands to activate or deactivated the desired measurements.
- Step 7: Click Next.



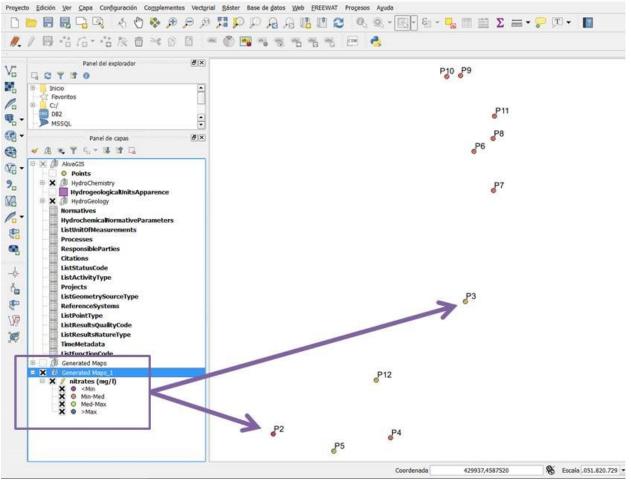
• *Step 8*: Map settings. Select the value to use in the map. Statistical calculations can be used to be represented in the maps such as average value, mean, minimum, etc.

STEP 9.1

| Q | | Save file | | | * |
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| ε | F | G | н | 1 | 1 |
| mpaign | Sample | Date | silicates (mg/l) | sulfates (mg/l) | nitrates (n |
| npaign9 | P1_CUP0611 | 2006-11-08 00:00:00.000 | 10.43 | 181.43 | 86.61 |
| npaign9 | P10_CUP0610 | 2006-10-25 00:00:00.000 | 9.28 | 165 | 16.7 |
| npaign7 | P11_CAG0110-00 | 5 2001-10-24 00:00:00.000 | | 239 | 14.1 |
| npaign9 | P12_CUP0612 | 2006-12-13 00:00:00.000 | 8.96 | 158.22 | 95.08 |
| npaign10 | P2_CPR1011 | 2010-11-24 00:00:00.000 | | 142.45 | 0.6 |
| mpaign8 | P3_CCL0301 | 2003-01-29 00:00:00.000 | | 236 | 57.9 |
| npaign9 | P3 CUP0610 | 2006-10-24 00:00:00.000 | 8.69 | 244.9 | 84.22 |

• *Step 9.1*: Save query results in different formats.

🔏 QGIS 2.18.3



• Step 9.2: This button creates automatically the map with the selected parameter.

2.10.1 How to edit / add new normatives and its limit values?

STEP 1

| AkveGIS AkveGIS Points MydroChemistry MydrogeologicalUnitsApparence | 12310 | B (| | ales: 2, filtrados: 2 6 9 7 3 8 | | | Actualizar I | todo Actualiza | ar lo seleccionado | |
|--|------------------|-------------|---|---|----------------------|------------------------|----------------------|----------------|--------------------|---|
| X HydroGeology Wells HydrogeologicalPointsObservations | | id 1 | normative EXDMA | asponsibleParty1 | name normativa de | nameEN normativa de | date 2017-03-20 1 | citation1d | srNormativesDe | |
| HydrogeologicalPointsMeasurements ListHydrogeologicalParametersCode | 2 | 2 | EXEWFD | EU | European Wat | European Wat | 2013-5-21 | NULL | | |
| WellsHydrogeologicalUnit HydrogeologicalUnits ListHydroUnitType | | | 0 | Normatives - Atri | outos del obje | to espacial | | | | |
| Normatives HydrochemicalliormativeParameters | | | | id | 3 | | | | | 4 |
| ListUnitOfMeasurements | | | | normative | CWD | | | | | (|
| Processes ResponsibleParties | | | | responsiblePartyId | | | | | | |
| Citations | | | | name | Catalan W | ater Directive | | | | |
| ListStatusCode ListActivityType | | | | nameEN | NUL | | | | | |
| Projects ListGeometrySourceType | | | | date | 2017-03-2 | 0 16:21:30 | | | | |
| ReferenceSystems | | | | citation1d | | | | | | |
| ListPointType ListResultsQualityCode | T Mo | strar todos | los objetos es | otherNormativesDe | tails NULL | | | | | |
| | (and the second | | and the second se | observations | NUKL | | | | | |

- *Step 1*: Edit or add a new normative if is not included in the table *Normatives*. Select *Normative* table and open its attribute table. The following data has to be added:
 - Id: Unique identifier number.
 - Normative: Short name of the normative.
 - *ResponsiblePartyId*: Responsible entity of this normative. In case this entity is not in the list, add a new entity in the *Responsible Party Table*.
 - Name: Long name of the normative in native language (recommended).
 - NameEN: Long name of the normative in English (recommended).
 - Date: Date of the normative (recommended).
 - *CitationId*: Unique identifier number of each citation of the document where the normative is described. In case the citation is not in the list, add a new citation in the table *Citation* (from the TOC) (recommended).
 - otherNormativeDetails: Additional data (recommended).
 - observations: Observations of the person that introduce the data into the database (recommended).

Note: After update normative information, do not forget to save the edition session.

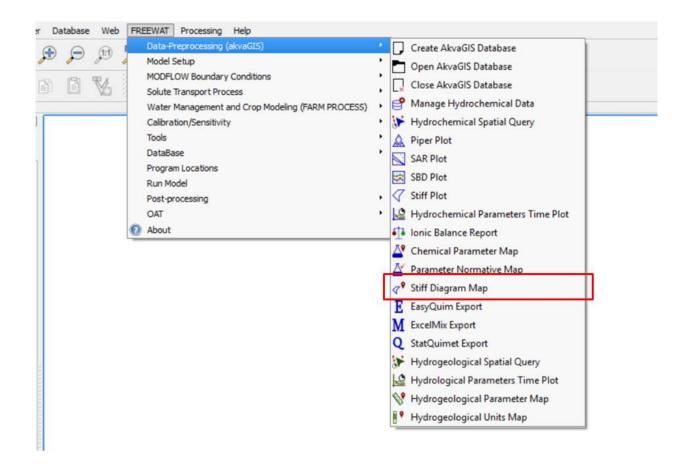
STEP 2

| AkvaGIS | 12 | normativeId | <u> </u> | • = 8 | | | | Actualizar tod | Actualizar lo | o seleccionado |
|--|----|--------------|----------------------|----------------|------------|------------|---------------------|----------------|---------------|----------------|
| K 🕼 HydroChemistry | | normativeld | emicalParamete | neterNormativ | far | nily | limMinNorm | limMedNorm | limMaxNorm | ramClassifi |
| K 🗿 HydroGeology | 8 | EXDMA | arsenic;ug/l (| | | | 5 | 10 | 50 | |
| Normatives HydrochemicalNormativeParame | 9 | EXDMA | HydrochemicalNo | ormativePara | neters - A | tributo | s del objeto espa | acial | | |
| ListUnitOfMeasurements | 10 | EXDMA | | | | | | | | |
| Processes ResponsibleParties | 11 | EXDMA | normativeId | | EXEWFD | | | | | |
| Citations | 12 | EXDMA | hydrochemicalPara | metersCode | nitrates;n | ng/l | | | | |
| ListStatusCode | 13 | EXDMA | parameterNormativ | veName | WaterFran | nework | Directive | | | |
| ListActivityType Projects | 14 | EXDMA | family | | NULL | | | | | |
| ListGeometrySourceType | 15 | EXDMA | limMinNorm | | 1 | 1 | | | | |
| ReferenceSystems ListPointType | 16 | EXDMA | limMedNorm | | 50 | 2 | | | | |
| ListResultsQualityCode | 10 | EXDMA | limMaxNorm | | 100 | - | 3 | | | |
| ListResultsNatureType TimeMetadata | 1/ | (DUDUD | paramClassification | 1 | NULL | | 3 | | | |
| ListFunctionCode | 18 | | paramClassification | | NULL | | | | | |
| | F | Mostrar todi | ato ano na mandra an | | | | | | | |
| | 1 | | otherHydrochemNo | rmativeDetails | | | | | | |
| | | | observations | | Source Th | ne Nitrati | es Directive (1991) | | | |

- *Step* 2: Add/editing threshold values for each parameter for each normative. The user can introduce 3 limits: Minimum (1), Medium (2) and Maximum (3) in *Hydrochemical Normative Parameter* table. These limit values will be used to create automatic maps with different colors for each limit value (e.g. red for higher values than the maximum acepted by the normative, blue for lower values than the minimum acepted by the normative).
 - NormativeId: Unique identifier number of each normative stored in akvaGIS database.
 - *HydrochemicalParametersCode*: Chemical Parameter to update in the table. All this chemical parameters are stored in *ListHydrogeologicalParametersCode* table.
 - ParameterNormativeNale: Name of the Normative.
 - *family*: Classification of the different parameters following users defined normative/criteria for its subsequent classification according to the threshold approach established by a given guideline/normative.
 - *limMinNorm*: Threshold value 1 for a given paramater for a given normative.
 - *limMedNorm*: Threshold value2 (> than limMinNorm) for a given parameter for a given normative.
 - *limMaxNorm*: Threshold value 3 (> que LimMedNorm) for a given paramater for a given normative.
 - paramClassification: Classification parameter1-2 by the normative.
 - otherhydrocheNormativeDetails: Additional data (recommended).
 - observations: Observations of the person that introduce the data into the database (recommended)

Note: After update normative parameters information, do not forget to save the edition session.

2.11 Stiff Diagram Map



Use this command to create the Stiff diagram map for the selected query created previously with the tool shown in section 2.2 *Hydrochemical Spatial Query*. For obtaining single stiff diagrams, use command Stiff Plot Tool in section 2.6 *Stiff Plot*. This diagram will be created only if the measurements required for the creation of this diagram are avalable in the akvaGIS Database.

| 1 | | Stiff Measurements | | | 2 | |
|----------------------------------|-----------------------------|--------------------|----------------|----------------------------------|------------------------------|--|
| leasurements Query | Parameters | | | | | |
| only2Points | Available Parameters | | Used Parameter | s: | | |
| AllPoints NorthernPoints | Name | - | Name | imit Fa | > Limit Factor | |
| JserManual | isotopes Water dDeuteri | | magnesium | 1,00 1,00 | | |
| | % Sat Oxygen | | bicarbonate | 1,00 | 1,00 1,00 1,00 1,00 | |
| | 1 - phenyl -1- cyclohexenyl | > | sodium | 1,00 | 1,00 | |
| | 1,1 - Dichloroacetone | | calcium | 1,00 | 1,00 | |
| | | Run Query | | 1 | | |
| Active Measurements | Р 1 | | STEP | 1 | | |
| Active Measurements STE Activate | P 1 Deactivate | | STEP | 1 2 Select A | | |

- Step 1: Choose the Query created previously with the tool shown in section 2.2 Hydrochemical Spatial Query.
- *Step 2*: Choose the limit factor to be applied to the censored values. With this tool the user has the option to substitute the censored values by this factor times the detection limits. The censored values are the concentration of some elements reported as less than, < limit factor, or greater than, > limit factor.

| | s Query | 2000-000-0 | | | | | | |
|----------------------------|----------------|---------------------|-------------------------|--------------|-----------------------|---------|------------|------------|
| ample Quer | У | Parameters | | | | | | |
| only2Points AllPoints | | Available Paramete | rs | 10 | Used Parameters | ę | 1 | |
| NorthernPoir JserManual | nts | | Name | Ē | Name | imit Fa | > Limit Fe | actor |
| Jsermanual | | isotopes Water di | Deuteri | | magnesium | 1,00 | 1,00 | : |
| | | % Sat Oxygen | | 2 | bicarbonate | 1,00 | 1,00 | : |
| | | 1 - phenyl -1- cycl | ohexenyl | | sodium | 1,00 | 1,00 | 1 |
| | | 1,1 - Dichloroacetr | one | * < | calcium | 1,00 | 1,00 | |
| easurement ctive Measu | No. and States | | | tun Query | | | EP 3 | |
| Active | Point | Sample | Sample Date | Campaign | Measurement Dat | e | Parameter | Val |
| × | P10 | P10_CUP9711-00 | 4 1997-11-20 00:00:00.0 | 00 Campaign3 | 1997-11-20 00:00:00.0 | 00 bid | arbonate | 480,7 |
| × | P10 | P10_CUP9711-00 | 4 1997-11-20 00:00:00.0 | 00 Campaign3 | 1997-11-20 00:00:00.0 | 00 ca | lcium | 175 |
| × | P10 | P10_CUP9711-00 | 4 1997-11-20 00:00:00.0 | 00 Campaign3 | 1997-11-20 00:00:00.0 | 00 ch | loride | 252 |
| × | P10 | P10_CUP9711-00 | 4 1997-11-20 00:00:00.0 | 00 Campaign3 | 1997-11-20 00:00:00.0 | 00 ma | sgnesium | 41,8 |
| × | P10 | P10_CUP9711-00 | 4 1997-11-20 00:00:00.0 | 00 Campaign3 | 1997-11-20 00:00:00.0 | 00 so | dium | 175 |
| × | P10 | P10_CUP9711-00 | 4 1997-11-20 00:00:00.0 | 00 Campaign3 | 1997-11-20 00:00:00.0 | 00 su | lfates | 193 |
| × | P10 | P10_CUP0610 | 2006-10-25 00:00:00.0 | 00 Campaign9 | 2006-10-25 00:00:00.0 | 00 bk | arbonate | 401,38 |
| × | P10 | P10_CUP0610 | 2006-10-25 00:00:00.0 | 00 Campaign9 | 2006-10-25 00:00:00.0 | 00 ca | lcium | 134,8 |
| × | P10 | P10_CUP0610 | 2006-10-25 00:00:00.0 | 00 Campaign9 | 2006-10-25 00:00:00.0 | 00 ch | loride | 193 |
| × | P10 | P10_CUP0610 | 2006-10-25 00:00:00.0 | 00 Campaign9 | 2006-10-25 00:00:00.0 | 00 ma | agnesium | 28 |
| | 11 | | | | | | | |
| Activate | Dea | ctivate | | | | Select | All De | select All |
| _ | _ | | | | | Nex | đ | Close |
| | | | | | | - | _ | |

- Step 3: Run Query.
- *Step 4*: Use this commands to activate or deactivated the desired measurements.
- Step 5: Click Next.

| esu | It Samples | _ | | | | | | | | | |
|-----|--|----------------|---------|----------|-----------|---------------------------|-----------|-----------|------------|---|---|
| | Point | Campaign | Sample | Date | cium (mec | oride (mea | nesium (m | dium (mec | fates (mec | | |
| 1 | P1 | Campaig | P1_CUP0 | 2006-11 | 4,8965 | 2,65268 | 4,86942 | 2,81478 | 3,77979 | | |
| 2 | P10 | Campaig | P10_CUP | 2006-10 | 6,74 | 5,43662 | 2,31405 | 6,25217 | 3,4375 | | |
| 3 | P11 | Campaig | P11_CAG | 2001-10 | 7,81 | 9,91549 | 2,72727 | 9,83043 | 4,97917 | | |
| 4 | P12 | Campaig | P12_CUP | 2006-12 | 6,4925 | 3,94056 | 4,10909 | 3,60696 | 3,29625 | | |
| 5 | P2 | Campaig | P2_CPR1 | 2010-11 | 6,534 | 5,81437 | 2,31488 | 6,36217 | 2,96771 | | |
| 6 | P3 | Campaig | P3_CCL0 | 2003-01 | 7,32 | 4,61972 | 4,42975 | 6,19565 | 4,91667 | | |
| 7 | P3 | Campaig | P3_CUP0 | 2006-10 | 7,1295 | 5,1431 | 3,91653 | 6,42652 | 5,10208 | | |
| 8 | P4 | Campaig | P4_CPR1 | 2010-05 | 6,108 | 5,66817 | 2,35372 | 7,17391 | 3,03229 | | |
| 9 | P5 | Campaig | P5_CCL0 | 2003-01 | 10,38 | 8,59155 | 5,66942 | 6,61304 | 9,14167 | | |
| 10 | P5 | Campaig | P5_CPR1 | 2010-05 | 5,864 | 5,15521 | 2,16364 | 6,78565 | 2,89875 | | |
| 11 | P7 | Campaio | P7 CUP0 | 2006-09- | 7.395 | 5.83099 | 2.65289 | 7.33478 | 3.64583 | | |
| Va | ap settings lue to use – ff settings – Pk | E theight (Ler | | Latest ● | |) Minimum cale (meq/Le | Maxim | | | ← | S |
| | | | | | | Save Table | Ма | ар | Close | | |

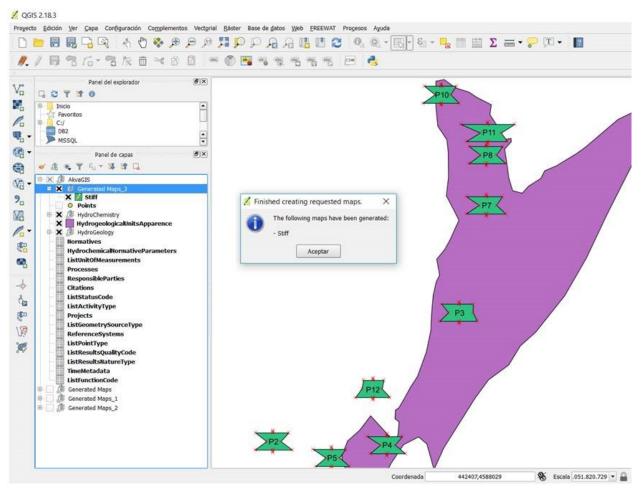
• *Step 6*: Map settings (optional). Select the value to use in the map. Statistical calculations can be used to be represented in the maps such as average value, mean, minimum, etc.

Using the Stiff settings it is possible to choose the plot height and the horizontal scale. To plot settings such as stiff colour see layer properties.

STEP 7.1 Save file Ó 🔶 → ≠ ↑ 📜 - wp2 + UserManualTest7112015 + ◦ 6 Buscar en UserManualTest7112... III • Organizar * Nueva carpeta 0 1 Sitios recientes . Fecha de modificaci... Tipo Nombre 🗼 bbdd 07/11/2015 3:43 Carpet 🔺 Este equipo 👍 Descargas E Documentos Escritorio 🗼 Imágenes 🌡 Música Videos 🔩 OS (C:) Red Red < Nombre: userManualTest Tipo: LibreOffice (*.ods) Guardar Cancelar Ocultar carpetas

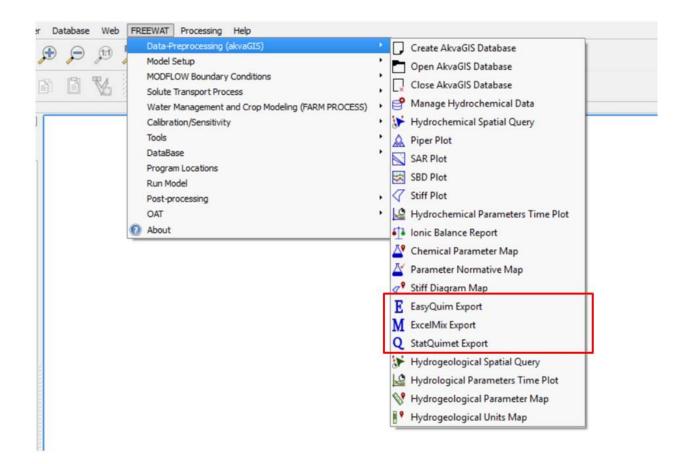
| | 24 | 0 | K. | Q. | n in | 5 | | Q.1 | V | W |
|----|-----------------|---------------|--------------|-----------------|------------------|-------------------|----------------|------------------|---------------------|----------|
| 1) | sulfates (mg/l) | sodium (mg/l) | sodium (ppm) | calcium (meq/l) | chloride (meq/l) | magnesium (meq/l) | sodium (meg/l) | sulfates (meq/l) | bicarbonate (meq/l) | valid |
| | 181.43 | 64.74 | | 4.8965 | 2.652676056 | 4.869421488 | 2.814782609 | 3.779791667 | 4.983606557 | VERDADER |
| | 165 | 143.8 | | 6.74 | 5.436619718 | 2.314049587 | 6.252173913 | 3.4375 | 6.58 | VERDADER |
| | 239 | 226.1 | | 7.81 | 9.915492958 | 2.727272727 | 9.830434783 | 4.979166667 | 7.196721311 | VERDADER |
| | 158.22 | 82.96 | | 6.4925 | 3.94056338 | 4.109090909 | 3.606956522 | 3.29625 | 6.180327869 | VERDADER |
| | 142.45 | 146.33 | | 6.534 | 5.814366197 | 2.314876033 | 6.362173913 | 2.967708333 | 7.113606557 | VERDADER |
| | 236 | | 142.5 | 7.32 | 4.61971831 | 4.429752066 | 6.195652174 | 4.916666667 | | FALSO |
| | 244.9 | 147.81 | | 7.1295 | 5.143098592 | 3.916528926 | 6.426521739 | 5.102083333 | 6.64 | VERDADER |
| | 145.55 | 165 | | 6.108 | 5.668169014 | 2.353719008 | 7.173913043 | 3.032291667 | 6.833934426 | VERDADER |

• Step 7.1: Save Stiff query results in different formats such as .ods.



• *Step 7.2*: Plot Stiff diagram automatically. The resulting layer will be automatically loaded into the bottom of the Layer Panel.

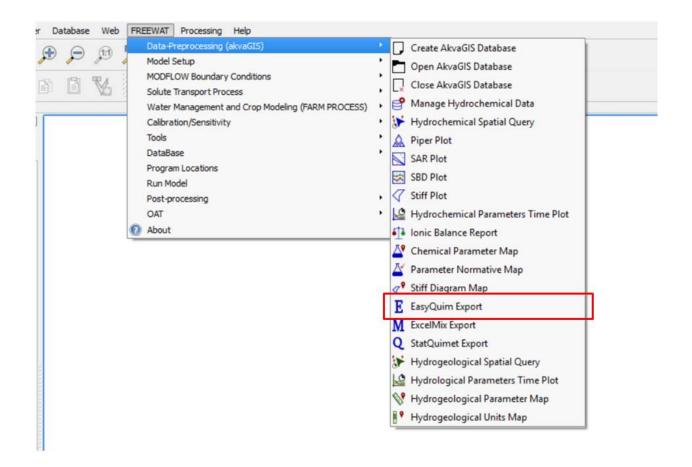
2.12 Export Tools



This set of tools enables us to use different query criteria to be exported to external formats (e.g. ods, xls or csz files). In addition allow us to export the query data to further external platforms (e.g. Easy_Quim, MIX or Statistical Tools).

For more information see: http://h2ogeo.upc.edu/en/investigation-hydrogeology/software

2.13 Export Major lons



This tool provides a query form that enables the user to automatically query the common major ions of the selected sample query.

| Measurements Query Sample Query | Parameters | | | | |
|------------------------------------|-----------------------------|---|----------------|-----------------------|----------------|
| only2Points AllPoints | Available Parameters | | Used Parameter | rs: | |
| NorthernPoints | Name | | Name | imit Fa | > Limit Factor |
| UserManual | isotopes Water dDeuteri | | ammonia | 1,00 📜 | 1,00 |
| | % Sat Oxygen | | magnesium | 1,00 📜 | 1,00 |
| | 1 - phenyl -1- cyclohexenyl | 8 | bicarbonate | 1,00 📜 | |
| | 1,1 - Dichloroacetone | < | sodium | 1,00 🕻 | 1,00 |
| Active Measurements | x. | | | T | |
| | D 1 | | TED | T | |
| STE | P 1 | | STEP | T ² | |
| STE | P 1 Deactivate | | STEP | T 2 Select Al | Deselect All |

- Step 1: Choose the Query created previously with the tool shown in section 2.2 Hydrochemical Spatial Query.
- *Step 2*: Choose the limit factor to be applied to the censored values. With this tool the user has the option to substitute the censored values by this factor times the detection limits. The censored values are the concentration of some elements reported as less than, < limit factor, or greater than, > limit factor.

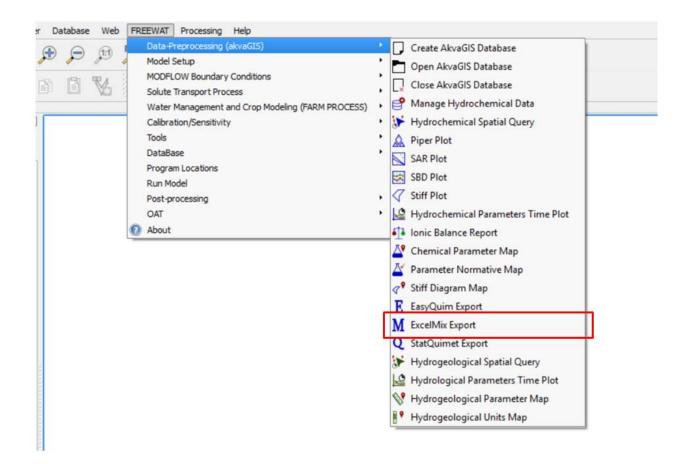
| feasuremen Sample Que | 0.00000 | Parameters | | | | | | |
|---------------------------|----------|--------------------------|--|----------|--------------------|-----------------------|------------------|-------|
| only2Points | | Available Param | eters | | Used Parameter | ns: | | |
| AllPoints NorthernPo | | | Name | | Name | imit Fr | > Limit Fac | |
| UserManua | | isotopes Water | 1.0001105 | Ц | ammonia | 10000000 | 1,00 | |
| | | % Sat Oxygen | | 8 | magnesium | and the second second | 1,00 | |
| | | 1 - phenyl -1- c | | > | bicarbonate | determination of the | 1,00 | 0.00 |
| | | 1.1 - Dichloroad | | 100 | sodium | in the second second | 1,00 | |
| | | Tit - Diculocoad | eune | * < | socium | 1,00 | - 1,00 | - 5 |
| leasuremen Active Meas | urements | | | | 1 | | | |
| Active | Point | Sample | Sample Date | Campaign | Measurement D | | Parameter | |
| × | P1 | P1_CUP0611 | 2006-11-08 00:00:00.000 | | 2006-11-08 00:00:0 | | Alkalinity (TAC | |
| × | P1 | P1_CUP0611 | 2006-11-08 00:00:00.000 | | 2006-11-08 00:00:0 | | EC | 10' |
| X | P1 | P1_CUP0611 | 2006-11-08 00:00:00.000 | | 2006-11-08 00:00:0 | | picarbonate | 30 |
| × | P1 | P1_CUP0611 | 2006-11-08 00:00:00.000 | | 2006-11-08 00:00:0 | | talcium | 97, |
| X | P1 | P1_CUP0611 | 2006-11-08 00:00:00.000 | | 2006-11-08 00:00:0 | | chloride | 94 |
| ×× | P1 P1 | P1_CUP0611 | 2006-11-08 00:00:00.000 | | 2005-11-08 00:00:0 | | nagnesium | 58 |
| Ŷ | P1 P1 | P1_CUP0611 P1_CUP0611 | 2006-11-08 00:00:00.000 | | 2006-11-08 00:00:0 | | nitrates oH | 86 |
| x | P1 | P1_CUP0611 P1_CUP0611 | 2006-11-08 00:00:00.000 2006-11-08 00:00:00.000 | | 2006-11-08 00:00:0 | | ootassium | 1,5 |
| | - | C4.4 | 3006 11-00 00.00.00.000 | | 3006 11 00 00.00.0 | | ouddesium | 51 |
| Activat | e Dea | ctivate | | | | Select All | Desele | 10.15 |
| | | | | | | Next | a | ose |
| | | 1 | | | 6 | - Fine | | |

- Step 3: Run Query.
- *Step 4*: Use this commands to activate or deactivated the desired measurements.
- *Step 5*: Click Next.

| | Point | Campaign | Sample | Date | EC (uS/cm | ature InSi | cium (mec | oride (mer | nesium (m |
|----|-------|----------|---------|---------|-----------|------------|-----------|------------|-----------|
| 1 | P1 | Campaig | P1_CUP0 | 2006-11 | 1090 | | 4,8965 | 2,65268 | 4,86942 |
| 2 | P10 | Campaig | P10_CUP | 2006-10 | 1388 | | 6,74 | 5,43662 | 2,31405 |
| 3 | P11 | Campaig | P11_CAG | 2001-10 | 1890 | 18,5 | 7,81 | 9,91549 | 2,72727 |
| 4 | P12 | Campaig | P12_CUP | 2006-12 | 1293 | 100 | 6,4925 | 3,94056 | 4,10909 |
| 5 | P2 | Campaig | P2_CPR1 | 2010-11 | 1413 | | 6,534 | 5,81437 | 2,31488 |
| 6 | P3 | Campaig | P3_CCL0 | 2003-01 | 1516 | | 7,32 | 4,61972 | 4,42975 |
| 7 | P3 | Campaig | P3_CUP0 | 2006-10 | 1556 | | 7,1295 | 5,1431 | 3,91653 |
| 8 | P3 | Campaig | P3-2013 | 2013-12 | | | | | |
| 9 | P4 | Campaig | P4_CPR1 | 2010-05 | 1383 | | 6,108 | 5,66817 | 2,35372 |
| 10 | P4 | Campaig | P4-2013 | 2013-12 | | | | | |
| 11 | P5 | Campaig | P5_CCL0 | 2003-01 | 2006 | | 10,38 | 8,59155 | 5,66942 |
| 12 | P5 | Campaig | P5_CPR1 | 2010-05 | 1277 | | 5,864 | 5,15521 | 2,16364 |
| 13 | P5 | Campaig | P5-2013 | 2013-12 | | | 121 | 1 | |
| 14 | P5 | Campaig | P5-2014 | 2014-01 | | | | | |
| 15 | P6 | Campaig | P6-2013 | 2013-12 | | | | | |
| 16 | P6 | Campaig | P6-2014 | 2014-01 | | | | | |
| 17 | P7 | Campaig | P7_CUP0 | 2006-09 | 1459 | | 7,395 | 5,83099 | 2,65289 |
| • | | | | | | | | - | |
| | | | | | | Save Table | Export | t data | Close |
| | | | | | | - | | | |

- *Step 6*: Save table where the selected parameters for the selected points are shown.
- *Step 7*: Export query results to different formats (.xls, .csv, .ods) including the query of the major ions for the selected Query (i.e. for the selected points in the desired intervals). The resulting spreadsheet follows the required format of EasyQuim.

2.14 Export to Mixing



Mixing calculations involve computing the ratios in which two or more end-members are mixed in a sample. Mixing calculations are useful for a number of tasks in hydrology, such as hydrograph separation, water or solute mass balances, and identification of groundwater recharge sources. Most methods available for computing mixing ratios are based on assuming that end-member concentrations are perfectly known, which is rarely the case. Often end-members cannot be sampled and their concentrations vary in time and space. Still, much information about them is contained in the mixtures. To take advantage of this information, a maximum likelihood method to estimate mixing ratios, while acknowledging uncertainty in end-member concentrations can be exported to used it in an external free software. Maximizing the likelihood of concentration measurements with respect to both mixing ratios and end-member concentrations leads to a general constrained optimization problem. Results allow us to conclude that the method outperforms traditional approaches, such as least squares or linear mixing, in the computation of mixing ratios.

This tool provides a query form that enables the user to apply different query criteria oriented to evaluate the mixing ratios of the samples. As result, a classification of the samples in end members(that is, samples that represents the extreme composition of a mixing) or in samples members can be obtained for the selected parameters.

| asurements Query ample Query only2Points | Parameters STEF | 2 Used Parameters: | |
|--|--|--------------------|--|
| NorthernPoints | Name | A Name | < Limit Flactor > Limit Flactor |
| IserManual IQ | pH InStu | nitrates | 1.00 |
| | Phenanthrene | subhides | 1.00 |
| | phenois | suffetes | 1.00 1. |
| | chosphates | | 1.00 2 1.00 2 |
| | Manual Contraction of | magnesium | 1.00 1.00 1 |
| | phosphorus | Calcium | 1.00 + 1.00 + + |
| wenerts we Measurements | | | |
| CTED | 1 3 | IEF 3 | |
| STEP | | | |

- Step 1: Choose the Query created previously with the tool shown in section 2.2 Hydrochemical Spatial Query.
- *Step 2*: Choose the parameter to be queried for the analysis.
- *Step 3*: Choose the limit factor to be applied to the censored values. With this tool the user has the option to substitute the censored values by this factor times the detection limits. The censored values are the concentration of some elements reported as less than, < limit factor, or greater than, > limit factor.

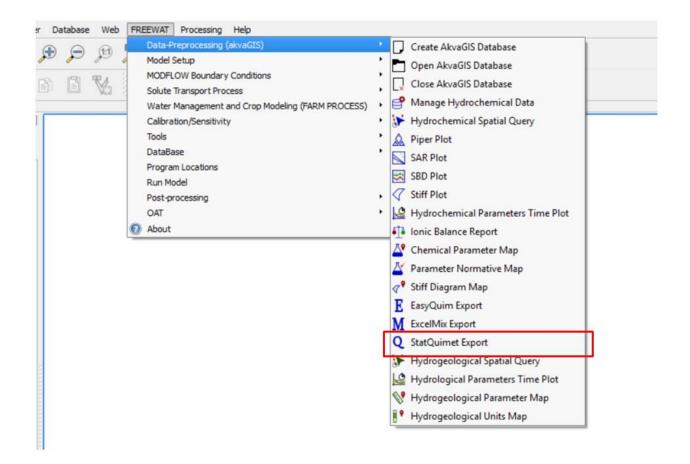
| surements | | 1000 | 2011-024-5 | | | | | | | | | |
|--------------------------|--------------|-----------------|---------------------------|-----------|---------------------|----------|-----------|--------|------|--------------------|---------|------|
| mple Query nly2Points | r | | Parameters | | | | | | | | | |
| Points | | | Available Parameters | | | | Used Par | | | | | |
| serManual Q | 13 | | | Name | A | | - | Name | | < Limit Factor > I | | f |
| 4 | | | Pesticide Total Summatory | | | | nitrates | | | 1.00 | • •0 | L |
| | | | pH | | | | sulphide | 15 | | | • • | Į |
| | | | pH (lab) | | | | sulfates | 1 | | 1.00 | • | |
| | | | pH InSitu | | | | magnesi | ium - | | 1.00 | 00 🗘 | T |
| | | | Phenanthrene | | | > | calcium | | | 1.00 | 00 | |
| | | | nhannle | | | < | | envola | | 1.00 | | |
| Active | Point | Sample | Sample Date | Campaign | Measurement Da | te | Parameter | Value | Unit | Is Calcu | lated | - |
| Active | Point | Sample | Sample Date | Campaign | Measurement Da | te | Parameter | Value | Unit | 1s Calcu | ated / | |
| × | Pt | P1_CUP0611 | 2006-11-08 00:00:00.000 | Campaign9 | 2006-11-08 00:00:00 | .000 cai | olum | 97.93 | ng/l | 1 | | _ |
| × | P1 | P1_CUP0611 | 2006-11-08 00:00:00.000 | Campaign9 | 2006-11-08 00:00:00 | .000 ma | gnesium | 58.92 | ng/t | 1 | | |
| × | P1 | P1_CUP0611 | 2006-11-08 00:00:00.000 | Campaign9 | 2006-11-08 00:00:00 | .000 sul | fates | 181.43 | mg,8 | | | |
| × | P10 | P10_CUP0610 | 2006-10-25 00:00:00.000 | Campaign9 | 2006-10-25 00:00:00 | .000 cal | dum | 134.8 | mg/š | 1 | | |
| × | P10 | P10_CUP0610 | 2006-10-25 00:00:00.000 | Campaign9 | 2006-10-25 00:00:00 | .000 ma | gnesium | 28 | mg/t | 1 | | |
| × | P10 | P10_CUP0610 | 2006-10-25 00:00:00.000 | Campaign9 | 2006-10-25 00:00:00 | .000 sul | fates | 365 | ng,6 | 1 | | |
| × | P11 | P11_CAG0110-005 | 2001-10-24 00:00:00.000 | Campaign7 | 2001-10-24 00:00:00 | .000 cal | oum | 156.2 | mg/f | 1 | | |
| × | P11 | P11_CAG0110-005 | 2001-10-24 00:00:00.000 | Campaign7 | 2001-10-24 00:00:00 | .000 ma | gnesium | 33 | ng/t | 1 | | |
| Activate | Deactr | vate | | | | | | | - | Select All | Deselec | cti |
| Sectore and | 111 11205000 | | | | | | | | - F | | | 0.00 |
| | | 1 | | | | | | | -1 | Next | 00 | 258 |
| | | | | | STE | _ | | | - | | | - |

- *Step 4*: Run Query.
- *Step 5*: Use this commands to activate or deactivated the desired measurements.
- Step 6: Click Next.

| Pentid Pent Coordnate X Coordnate Y Carpaign Sample Date magnetism (mgl) magnetism (mgl) <th< th=""><th>sult</th><th>Samples</th><th></th><th></th><th></th><th></th><th></th><th></th><th>0</th><th>115.52</th><th></th><th>UPPER STREET</th></th<> | sult | Samples | | | | | | | 0 | 115.52 | | UPPER STREET |
|---|------|-----------------|----------------------|--------------|--------------------------------------|--|---|-----------------|----------------------------|------------------|-----------------|--------------|
| 1 1 P1 0 0 Campositive P1_CLOPE11 000000.0000 000000.0000 000000.0000 38.92 2 2 P10 0 0 Campositive P10_CLOPE11 000000.0000 000000.0000 000000.0000 33 3 P11 0 0 Campositive P11_CAG0110-005 000000.0000 33 0 4 4 P12 0 0 Campositive P12_CLEP6121 000000.0000 000000.0000 000000.000 47.72 5 5 P2 0 0 Campositive P12_CLEP6121 000000.000 000000.000 000000.000 53.6 6 6 P3 0 0 Campositive P1_CLEP610 0000000.000 000000.000 47.39 0 8 7 P4 0 0 Campositive P3_CLEP610 0000000.000 000000.000 28.40 0 0000000.000 28.40 0 0000000.000 28.40 0 0000000.000 28.40 0 0000000.000 28.40 0 00000 | | Point3d | Point | Coordinate X | 0 | oordinat | e Y Campaign | Sample | Date | magnesium (mg.f) | magnesium (ppm) | 14 |
| 4 2 P10 0 0 Carressign P10,000000 X0 3 911 0 0 Carressign P11,00000000 33 1 4 4 P12 0 0 Carressign P11,00000000 33 1 5 5 P2 0 0 Carressign P12,000612 200:010-000 40.01 6 6 P3 0 0 Carressign P2,00001 200:010-000 200:010-000 20.01 6 6 P3 0 0 Carressign P2,00001 200:010-000 47.29 200:000000 20.48 200:0000000 20.48 200:0000000 20.48 200:0000000 20.48 200:0000000 200:0000000 20:48 200:00000000 20:48 200:00000000 20:48 200:00000000 20:48 200:00000000 20:48 200:000000000 20:48 200:00000000 20:48 200:00000000 20:48 200:000000000 20:48 200:0000000000 20: | 1 | 1 | P1 | 0 | 0 | | Campaign9 | P1_CUP0611 | | 58.92 | | 97. |
| a 3 P11 0 0 Campaign? P11_CAUD10000 000000.0000 33 4 4 P12 0 0 Campaign? P12_CLPR1011 000000.000 33 5 5 P2 0 0 Campaign? P12_CLPR1011 2000-D00 28.01 6 6 P3 0 0 Campaign? P3_CCL0301 2000-D00 28.01 53.6 7 6 P3 0 0 Campaign? P3_CLP0610 2000-D02.4 47.39 8 P5 0 1.55889e-73 Campaign.0 P4_CPR10111 2000-00.02 28.48 9 8 P5 0 1.55889e-73 Campaign.0 2000-00.02 28.48 68.6 | z | z | P10 | 0 | 0 | | Campaign9 | P10_CUP0610 | | 29 | | 134 |
| Image: Solution of the second secon | 3 | 3 | P11 | Ċ. | 0 | | Campaign7 | P11_CAG0110-005 | 2001-10-24 00:00:00.000 | 33 | | 151 |
| a b p p 0 0 Campaigned p 2000-00-000 20101 6 6 p3 0 0 Campaigned p3_CCL0301 0000-00-000 \$3.6 7 6 p3 0 0 Campaigned p3_CCL0301 0000-00-000 \$3.6 8 7 p4 0 0 Campaigned p3_CCL0301 0000-00-000 \$3.6 9 8 p5 0 1.518898-73 Campaigned P4_CPR1011 0000-00-000 \$6.6 | 4 | 4 | P12 | 0 | 0 | | Campaign9 | P12_CUP0612 | | 49.72 | | 125 |
| b b p2 0 0 Campages P3_CL0.001 000000.000 \$3.6 7 6 p3 0 0 Campager9 P3_CLP0610 000000.000 \$7.29 8 7 P4 0 0 Campager8 P3_CLP0610 000000.000 \$7.29 \$3.6 9 8 P5 0 1.51289e-73 Campager8 P5_CCL0301 2001-01-38 \$000000.000 \$8.6 Mx settings Choose end members and samples to export | 5 | 5 | P2 | 0 | 0 | | Campaign 10 | P2_CPR1011 | | 28.01 | | 130 |
| Image: Point of the second service of the s | 6 | 6 | P3 | 0 | 0 | | Campaign8 | P3_CCL0301 | 2003-01-29 00:00:00.000 | | \$3.6 | 1 |
| Image: Particity | 7 | 6 | P3 | ¢. | 0 | | Campaign9 | P3_CUP0610 | | 47.39 | | 140 |
| x p 0 158898*73 Campages P3_CLI0.01 00:00:00.000 p85.8 Mix settings Choose end members and samples to export Image: The temperature is End Member Image: The temperatemathematic is End Member | 8 | 7 | P4 | 0 | 0 | | Campaign 10 | P4_CPR1011 | | 20.48 | | 12; |
| Mx settings Choose end members and samples to export Image: Active Sample name is End Member Image: Active Sample name is End Member Image: Active Sample name is End Member Image: Active Sample name is End Member Image: Active Sample name is End Member Image: Active Sample name is End Member Image: Active Sample name is End Member Image: Active Sample name is End Member Image: Active Sample name is End Member Image: Active Sample name is End Member | 9 | 8 | PS | 0 | 1.51 | 889e-73 | Campaign8 | P5_CCL0301 | | | 68.6 | |
| Active Sample name Is End Member Image: Sample name | • | | | | | | | | | | | |
| 7 X P3_0UP0610 X 8 X P4_0PR1011 | ch | cose end member | s and samples to exp | ort. | 2 | × | P1_CUP0611 P10_CUP0610 | D | | - S | TEP | 7 |
| B X P4_CPR1011 9 X P5_CCL0301 Save Table Export data | ch | oose end member | s and samples to exp | æt | 2 3 4 | × × × | P1_CLP0611 P10_CLP0610 P11_CA00110-005 P12_CLP0612 | | | - S | TEP | 7 |
| 9 X P5_C0.0301 | ch | oose end member | s and samples to exp | | 2 3 4 5 | × × × × × | P1_CUP0611 P10_CUP0610 P11_CAG0110-005 P12_CUP0612 P2_CPR1011 | | | - S | TEP | 7 |
| Save Table Export data | ch | oose end member | s and samples to exp | ort. | 2 3 4 5 6 | × × × × × | P1_CLP0611 P10_CLP0610 P11_CAG0110-005 P12_CLP0612 P2_CPR1011 P3_CCL0301 | | | - S | TEP | 7 |
| | ch | oose end member | s and samples to exp | | 2 3 4 5 6 7 | * * * * * * | P1_CIP0611 P10_CIP0610 P11_CA60110-005 P12_CIP0612 P2_CPR1011 P3_CIP0610 P3_CIP0610 | | | - S | TEP | 7 |
| SIEPO | 6 | oose end member | s and samples to exp | æt | 2 3 4 5 6 7 8 | * * * * * * * | P1_CLP0611 P10_CLP0610 P11_CA60110-005 P12_CLP0612 P2_CPR1011 P3_CLP0610 P3_CLP0610 P4_CPR1011 | · | | - S | TEP | 7 |
| | 6 | oose end member | s and samples to exp | ort. | 2 3 4 5 6 7 8 9 | x x x x x x x x x x | P1_CIP0611 P10_CIP0610 P11_CA60110-005 P12_CIP0612 P2_CPR1011 P3_CCL0301 P3_CIP0610 P4_CPR1011 P5_CCL0301 | · | | | | 7 |

- *Step 7*: Select the end member. If the sample is not selected, it is considered as sample. Here the user select if the sample is a mixing of the recharge sources or an end member (unique recharge source sample).
- Step 8: Save table where the selected parameters for the selected points are shown.
- *Step 9*: Export query results to different portable format (e.g. .xls, .csv,.ods) including the query of end members and sample members. The resulting spreadsheet follows the required format of Mix.

2.15 Export to Statistical Analysis



This tool enables us to obtain for the selected query sample and for the selected parameters different portable reports for further analysis (e.g. further statistical analysis). The statistical analysis performed with the related external platform could provide additional statistical analysis to the statistical analysis already provided with the different instruments included in AkvaGIS.

| surements Query Imple Query nly3Points Monints | Parameters STEP | 2 Used Parameters: | | |
|---|----------------------|--------------------|----------------|----------------|
| iorthemPoints ise:Manual | Name | A Name | < Limit Factor | > Limit Factor |
| Q | cadmium | sodum | 1.00 | 1.00 |
| | ceicun | sulfates | 1.00 | 1.00 |
| | camphene | nitrates | | 1.00 ÷ |
| | Camphore | pri l | 8872 | 1.00 |
| | carbon dioxide | > phosphates | | 1.00 |
| | Carbon tatrachiosida | Technoster | | 1 m |
| | Bun Quen | / | 7 | |
| STEP 1 | | EP 3 | 7 | |
| ove Measurements | | / | 7 | |

- Step 1: Choose the Query created previously with the tool shown in section 2.2 Hydrochemical Spatial Query.
- Step 2: Choose the parameter to be queried for the analysis.
- *Step 3*: Choose the limit factor to be applied to the censored values. With this tool the user has the option to substitute the censored values by this factor times the detection limits. The censored values are the concentration of some elements reported as less than, < limit factor, or greater than, > limit factor.

| sasurements (| Sneuk | | | | | | | | | | | | - |
|----------------------------|---------|-----------------|--|-----------|---|--------|------------|---------|--------------|------------|-----------|------------------|----|
| Sample Query | | | Parameters | | | | | | | | | | |
| only2Points AlPoints | | | Available Parameters | | | | Used Para | meters: | | | | | |
| NorthernPoin UserManual | ts. | | | Name | | | | Name | <0 | nit Factor | > Limit F | - and the second | 3 |
| NQ | | | cadmium | | - Aller | | sodum | | 1.0 | | 1.00 | - | 1 |
| | | | calcom | | | | sulfates | | 1.0 | 1 | 1.00 | - | 1 |
| | | | camphene | | | | nitrates | | 1.0 | | 1.00 | 1 | 1 |
| | | | Camphore | | | | pH | | 1.0 | | 1.00 | | J |
| | | | carbon doxide | | | > | phospha | tes | 1.0 | | 1.00 | | Į |
| | | | Carlos tatractionia | | ÷ | < | rathera | | 10 | | 1.00 | | |
| Active | Point | Sample | Sample Date | Campaign | Measurement D | ate | Parameter | Value | Unit | 1 | Calcula | ed | F |
| asurements - | _ | | | | unconstructured . | - | 6 | 0 | TE | F 1 | + | _ | |
| ctive Measur | ements | | | | | | | | | | | | |
| 1.00 | | | and the second sec | | and the second se | | | | | 3 | | ed | f |
| * | P1 | P1_CUP0611 | 2006-11-08 00:00:00.000 | | 2006-11-08 00:00:0 | 222200 | рн | 7.5 | *C | _ | - | | ł |
| × | PI | P1_CUP0611 | 2006-11-08 00:00:00.000 | | 2006-11-08 00:00:0 | | phosphates | 27.09 | ug/l (micros | 10 | P. | | ł |
| × | PI | P1_CUP0611 | 2006-11-08 00:00:00.000 | Campaign9 | 2006-11-08 00:00:0 | 0.000 | sodum | 64.74 | ngi | _ | Ξ | | ł |
| × | PI | P1_CUP0611 | 2006-11-08 00:00:00.000 | Campaign9 | 2006-11-08 00:00:0 | 0.000 | suifates | 181.43 | ng/l | | 0 | | ł |
| × | P10 | P10_CUP0610 | 2006-10-25 00:00:00.000 | Campaign9 | 2006-10-25 00:00:0 | 0.000 | рн | 7.21 | °C | | | | l |
| × | P10 | P 10_CUP06 10 | 2006-10-25 00:00:00.000 | Campaign9 | 2006-10-25 00:00:0 | 0.000 | sodum | 143.8 | mg/t | | | | |
| × | P10 | P10_CUP0610 | 2006-10-25 00:00:00.000 | Campaign9 | 2006-10-25 00:00:0 | 0.000 | sulfates | 165 | mg/t | | | | ľ |
| × | P11 | P11_CAG0110-005 | 2001-10-24 00:00:00.000 | Campaign7 | 2001-10-24 00:00:0 | 0.000 | pH. | 7.51 | u, ph | | | | ľ |
| × | P11 | P11_CAG0110-005 | 2001-10-24 00:00:00.000 | Campaign7 | 2001-10-24 00:00:0 | 0.000 | phosphates | 25 | ug/t (micros | 1/0 | | | Į. |
| -11- | - | Ben 0050110-005 | 2001-10-24 00:00:00.000 | Campaign7 | 2001-10-24 00:00:0 | 0.000 | sodum | 226.1 | mg,t | | | | È |
| Activate | Deactiv | rote | | | | | | | | Select Al | D | eselect | Aŝ |
| _ | | -12 | | | | | | | | Next. | | Cos | |
| | | | | | | | | - | | | | 1000 | - |
| | | | | | STE | | | 100 | | | | | |

- *Step 4*: Run Query.
- *Step 5*: Use this commands to activate or deactivated the desired measurements.
- Step 6: Click Next.

| | PointId | Point | Coordinate X | Coordinate Y | Campaign | Sample | Date | phates (ug/l (micro | sulfates (mg/l) | |
|----|---------|-------|--------------|--------------|-------------|-----------------|----------------------------|---------------------|-----------------|-------|
| 1 | 1 | P1 | 0 | 0 | Campaign9 | P1_CUP0611 | 2006-11-08 00:00:00.000 | 27.09 | 181.43 | 64. |
| 2 | 2 | P10 | 0 | 0 | Campaign9 | P10_CUP0610 | 2006-10-25 00:00:00.000 | | 165 | 142 |
| 3 | 3 | P11 | 0 | 0 | Campaign7 | P11_CAG0110-005 | 2001-10-24 00:00:00.000 | 25 | 239 | 226 |
| 4 | 4 | P12 | 0 | 0 | Campaign9 | P12_CUP0612 | 2006-12-13 00:00:00.000 | 6.69 | 158.22 | 82. |
| 5 | 5 | P2 | 0 | 0 | Campaign 10 | P2_CPR 1011 | 2010-11-24 00:00:00.000 | | 142.45 | 14 |
| 6 | 6 | P3 | 0 | o | Campaign8 | P3_CCL0301 | 2003-01-29 00:00:00.000 | | 236 | |
| 7 | 6 | P3 | 0 | 0 | Campaign9 | P3_CUP0610 | 2006-10-24 00:00:00.000 | 41.84 | 244.9 | 143 |
| 8 | 7 | P4 | 0 | 0 | Campaign 10 | P4_CPR1011 | 2010-05-30 00:00:00.000 | | 145.55 | 165 |
| 9 | 8 | PS | 0 | 0 | Campaign8 | P5_CCL0301 | 2003-01-28 00:00:00.000 | | 438.8 | |
| 10 | 8 | P5 | 0 | 0 | Campaign 10 | P5_CPR1011 | 2010-05-30 00:00:00.000 | | 139,14 | 156 |
| 11 | 10 | P7 | 0 | 0 | Campaign9 | P7_CUP0609 | 2006-09-24 00:00:00.000 | | 175 | 168 |
| | 11 | P8 | 0 | 0 | Campaign9 | P8_CUP0610 | 2006-10-24 | | 178.86 | 14 |
| • | | | | 0.01 | | | | | | • • |
| | | | | | | | 2 | Save Table | Export data | Close |
| _ | | | | | | 77 | | terminal to | | _ |

- Step 7: Save table where the selected parameters for the selected points are shown.
- *Step 8*: Two tables will be exported:

DATA_W file with all samples measurements including incompleted samples (samples without measurements for each of the selected parameters).

DATA file which store only samples with measurements for each of the selected parameter. This query can be used for the further statistical analysis using external platforms as Statistical Tools.

CHAPTER 3

Hydrogeological analysis tools

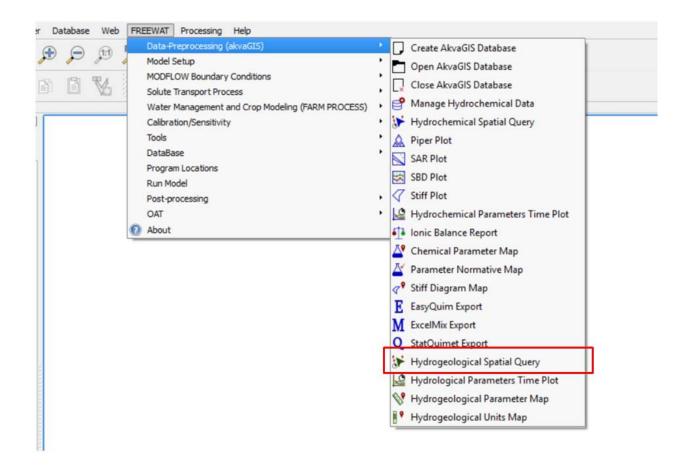
The **Hydrogeological Analysis Tools** sub-module of AkvaGIS form part of a wider framework developed into FREE-WAT platform.

These tools facilitate the management of different hydrogeological data with a wide range of methodologies for querying, interpreting, and comparing groundwater quantity data and facilitates the pre-processing analysis for being used in the realization of groundwater modelling.

The core of these tools is a geospatial database implemented in Spatialite which contains the hydrogeological spatiotemporal information, ready to be represented or analyzed.

More in detail, the hydrogeological set of tools improve the harmonization, integration, standardization, visualization and interpretation of hydrogeological data and allow us: (1) to manage and query the hydrogeological measurements (e.g. head, wells abstractions, etc.) performed in wells, piezometers, springs, etc. stored in the database; (2) to apply one or several query criteria (e.g. time interval, groundwater measurement) and to combine them for advanced spatio-temporal queries on the hydrogeological data stored in the database; (3) to create thematic maps (e.g. piezometric maps) of the selected points, time interval and parameters; (4) to calculate some general statistics such as the minimum, maximum or average for each selected hydrogeological parameter, such as head level, depth to the water or pumping rates; (5) to query the depth or the thickness of the defined hydrogeological units and to represent these values in a map as point features, with the possibility to interpolate results.

3.1 Hydrogeological Spatial Query



This tool enable us to query the hydrogeological measurements (e.g. head, wells abstractions, etc.) performed in wells, piezometers, springs, etc. This query only acts for those points where hydrogeological observations and measurements have been done. Please, see AckvaGIS database report.

STEP 1

| Query Editor | | | | | | |
|--|----------------|-----------------------|-------------------|------------|------------|--------------|
| Queries | V | Samples Time Interval | Spatial Selection | (Points) | | |
| only2Points AllPoints NorthernPoints | Add | | : | | | |
| lorthernPoints Iser niezoUSerManual | Remove | | | | | Refresh |
| | temove A | | | | | |
| | | | | Run | Query | |
| ctivate/Deactivate Q Filter | ueried Samples | | Active Samples | | | |
| by date | date 27/01/1 | | | | | |
| by points | | | | | | |
| | | Select All | | | | |
| | | Deselect All | | | | |
| | | | | | | |
| | Apply Filt | er | Activate | Deactivate | Select All | Deselect All |

• *Step 1*: Use this command to create and add to the database queries of the selected points (spatial selection) for the desired time interval. Also campaign can be used as a query criteria. Thus, hydrogeological tools can be applied to the queries stored in the database or it can be used in future analysis.

Note: Use the command *Remove* for deleting the selected query from the database or use the command remove all for removing all the queries from the database.

| | Panel del explorador | 88 | STEP 3 | |
|---|---|--|---|-------------|
| and the second se | logical Spatial Query | | STEP 2 STEP 2 | |
| Query Editor Queries only2Points NorthernPoin newQuery | | Samples Time 3 Start Date: 27/ End Date: 27/ | 1/2004 2 17 | P11 6 P8 |
| | Remove AI | | Rafreak STEP 4 | 87 |
| | activate Queried Samples | | Run Query | |
| Filter | Start dets 27/01/2000 (*) Ford data 27/01/2014 (*) 8 9 | Select All Deselect All | Active Samples Active Parte Observation Date Active Parte Observation Date 0 X P10 Need/Observation_F11 2005-58-01 00:00:00.000 0 X P11 Meed/Observation_F11 2005-58-01 00:00:00:00:000 0 | |
| | Apply Filter | - | Activate Deschwite Select All Deselect All Crose | |

- *Step 2*: Select (using inbuilt tools of QGIS) the points to be included in the query.
- *Step 3*: Select the desired time interval to be queried.
- *Step 4*: Refresh for visualize the new query.

| Q. | | Hydrogeol | ogica | al Spati | al Query | 5 | \$ | × |
|--|--|--|------------------|-------------------|-------------|---|------------------|--------------------|
| Query Editor | | 11150 11150 1015 1015 10 | | | | | | |
| Queries | | Samples Time Interval | Spa | tial Selection | on (Points) | | | |
| only2Points AllPoints NorthernPoints | Add | Start Date: 27/01/1900 End Date: 27/01/2014 | P1 P10 P11 | E. | | | - | |
| User piezoUSerMan | | | P12 P2 P3 | | | | | Refresh |
| | temove A | STEP 5 | P3 P5 | | | | Ð | |
| Activate/Deactiv Filter | vate Queried Sample | | | Samples Active | Point | Run Query Observation | D | ate |
| by date | Start date 27/01/1 End date 27/01/2 | 014 | 1 | × | P11 | headObservation_P1 | | -01 00: |
| by date | End date 27/01/2 | Select All | 1 | ×× | P10 | headObservation_P1 | 0 2003-08 | -01 00: -01 00: |
| - | End date 27/01/2 | | - | | P10 | | 0 2003-08 | |
| | End date 27/01/2 | Select All Deselect All | 2 | | P10 | headObservation_P1 STEP 6 (option | o 2003-06 al) | |

- Step 5: Run Query.
- *Step 6*: (Optional) Filter chosen any available query criteria (by date or by points).

| Query Editor | | 5 | | | | | | | | |
|--|--------------------------------------|-----------|------------------------------|----------------------|---------------------|--------------|------------------|-------------------------------|---------------|--------|
| Queries | | Samples T | Time Interval | Spa | tial Selection | on (Points) | | | 1.2 | |
| only2Points AllPoints NorthernPoints | Add | | : 27/01/1900 : 27/01/2014 | and a second | 1 | STE | P 7 | 7 | Î | |
| User piezoUSerMan | ual Remove | | | | P12 | | | al) | Ref | |
| | temove A | | | P2 P3 P4 P5 | | (op) | | iai) | ÷ | |
| | ate Queried Sample | es | | _ | | | | | | _ |
| Filter | start date 27/01/ | | | Active | e Samples Active | Point | | Observation | Dat | e |
| | | 1900 📮 | | Active 1 | Active X | Point P11 | | Observation oservation_P11 | Dat 2005-08-0 | - |
| Filter | Start date 27/01/ End date 27/01/ | 1900 📮 | | | Active | (10.5005) | headOt | | | 1 00:. |
| Filter | Start date 27/01/ End date 27/01/ | 1900 📮 | Select All | 1 | Active X | P11 | headOt | oservation_P11 | 2005-08-0 | 1 00:. |
| Filter | Start date 27/01/ End date 27/01/ | 1900 🗘 | Select All Deselect All | 1 | Active X | P11 | headOt | oservation_P11 | 2005-08-0 | 1 00:. |
| Filter by date | Start date 27/01/ End date 27/01/ | 1900 + | | 1 | Active X | P11 | headOl headOl | oservation_P11 | 2005-08-0 | 1 00:. |

• *Step* 7: (Optional) Activate/Deactivate the desired samples to be included in the query. For activate/deactivate please, select the row (also select all/deselect all).

Finally, click in close button to close the query form.

3.2 Time Plot. Hydrogeological Parameters

| Data-Preprocessing (akvaGIS) Create AkvaGIS Database Open AkvaGIS Database Open AkvaGIS Database Close AkvaGIS Database Close AkvaGIS Database Calibration/Sensitivity Hydrochemical Data Calibration/Sensitivity Image Hydrochemical Spatial Query Tools Image Piper Plot DataBase Image Sale Program Locations SBD Plot Run Model Image Sale | r Database Web | FREEWAT Processing Help | |
|---|----------------|--|---|
| Model Setup Image: Construction of the setup MODFLOW Boundary Conditions Image: Construction of the setup Solute Transport Process Image: Construction of the setup Water Management and Crop Modeling (FARM PROCESS) Image: Construction of the setup Calibration/Sensitivity Image: Construction of the setup Tools Image: Construction of the setup DataBase Image: Construction of the setup Program Locations SBD Plot | | | Create AkvaGIS Database |
| Post-processing OAT With Plot Hydrochemical Parameters Time Plot Ionic Balance Report Chemical Parameter Map Parameter Normative Map Stiff Diagram Map EasyQuim Export ExcelMix Export StatQuimet Export Hydrogeological Spatial Query Hydrological Parameters Time Plot | 0 0 0 | Data-Preprocessing (akvaGIS) Model Setup MODFLOW Boundary Conditions Solute Transport Process Water Management and Crop Modeling (FARM PROCESS) Calibration/Sensitivity Tools DataBase Program Locations Run Model Post-processing OAT | Open AkvaGIS Database Close AkvaGIS Database Manage Hydrochemical Data Hydrochemical Spatial Query Piper Plot SAR Plot SBD Plot Stiff Plot Hydrochemical Parameters Time Plot Ionic Balance Report Chemical Parameter Map Parameter Normative Map Stiff Diagram Map EasyQuim Export ExcelMix Export StatQuimet Export Hydrogeological Spatial Query |

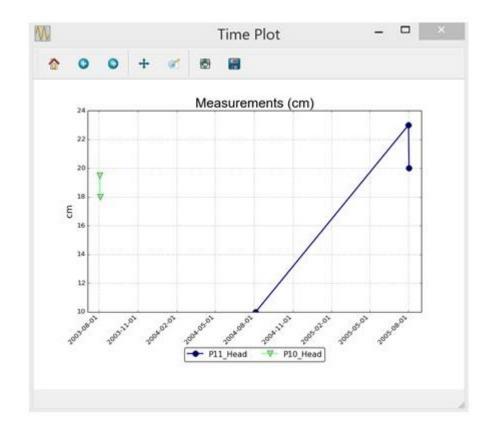
Use this command to create time plots of the selected query (created previously with the *Hydrogeological Spatial Query tool*, section 3.1) for the selected parameters.

| asurements | s Query | | | | | | | |
|-----------------------------------|--|---|--|-----------------------------------|-----------------------------------|----------------------|---------------|---|
| ample Query | ÷ | Paramete | rs | | 1 | | | _ |
| nly2Points IIPoints | | Available P | arameters | | | Used Paramet | bers: | |
| orthernPoints | ts | | Name | | | | Name | |
| orthernPoints wQuery STEP 1 | | Depth to V Flow Rate Pressure | | Head | | | | |
| asurements | 5 | | and the second | Run Query | > | | | |
| | | Observation | TEP 3 | Run Query | Value | Unit | Is Calculated | |
| tive Measure | ements | Observation | TEP 3 | _ | > | Unit | Is Calculated | |
| tive Measure Active | ements Point | Observation headObservation_P10 | Measurement Date | Parameter | Value | | Is Calculated | |
| Active Measure | Point P10 | Observation headObservation_P10 headObservation_P10 | Measurement Date 2003-08-03 00:00:00.000 | Parameter Head | Value 19,5 | cm | | |
| Active Measure | Pl0 P10 | Observation headObservation_P10 headObservation_P10 headObservation_P10 | Measurement Date 2003-08-03 00:00:00.000 2003-08-04 00:00:00.000 | Parameter Head Head | Value 19,5 18 | cm cm | | |
| Active Measure | Pin Pin Pin Pin Pin Pin | Observation headObservation_P10 headObservation_P10 headObservation_P10 headObservation_P10 | Measurement Date 2003-08-03 00:00:00.000 2003-08-04 00:00:00.000 2009-07-29 03:38:33.000 | Parameter Head Head Head | Value 19,5 18 20 | cm cm cm | | |
| Active Measure | Pl0 P10 P10 P10 P10 P10 | Observation headObservation_P10 headObservation_P10 headObservation_P10 headObservation_P11 | Measurement Date 2003-08-03 00:00:00.000 2003-08-04 00:00:00.000 2009-07-29 03:38:33.000 2013-07-07 03:37:09.000 | Parameter Head Head Head | Value 19,5 18 20 7000 | cm cm cm cm | | |

- Step 1: Choose the Query created previously with the Hydrogeological Spatial Query tool, section 3.1.
- *Step 2*: Choose the parameter to be queried for the analysis (e.g. head).
- Step 3: Run Query.
- *Step 4*: Use this commands to activate or deactivated the desired measurements.
- Step 5: Click Next.

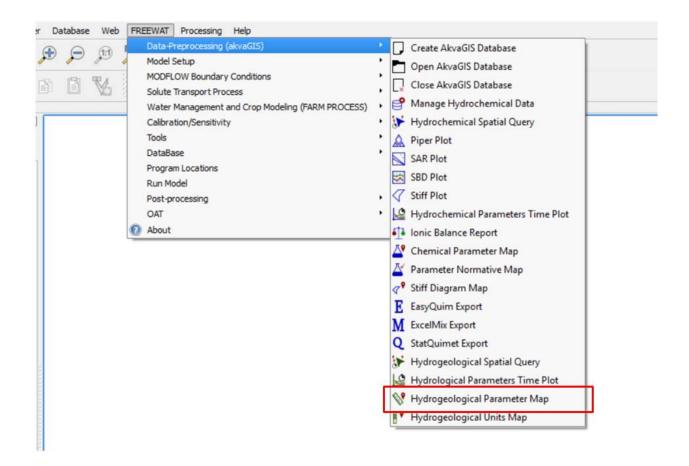
| | ult Samples - | | | | | | | | | |
|---|------------------------------------|-----------------------------|--------------------------------|-----------------------------|------------------------|---|----------------------|----------------------------|-------------|----|
| - | | 1 | | Laurau | 1 | | | | (| ĵ. |
| | PointId 2 | Point P10 | Coordinate X 432526 | Coordinate Y 4,58998e+06 | Sample headObservat | Date 2003-08-03 0 | 19.5 | Head | (cm) | |
| 1 | | | | | | | | | | |
| 2 | 2 | P10 | 432526 | 4,58998e+06 | headObservat | 2003-08-04 0 | 18 | | | |
| 4 | 2 | P10 | 432526 | 4,58998e+06 | headObservat | | 20 | | | |
| ł | 2 | P10 | 432526 | 4,58998e+06 | headObservat | 2013-07-07 0 | 7000 | | | |
| | Plot Size (pixels): 86 | 0 🗘 Y (pixe | is): 720 | Title Title: | Time Plot | | | | | |
| | - | | ls): 720 | | | Tont o | olor: [| Font s | ize: 24,0 🚦 | |
| | (pixels): 86 | | is): 720 🗘 | Title: | Arial | ▼ Font o | olor: | ▼] Font s | ize: 24,0 📑 | • |
| | (pixels): 860 DP1 80 | | ils): 720 | Title: Font type: | Arial | Legend | | | | 8 |
| | (pixels): 860 DP1 80 | ۲ | | Title: Font type: | Arial | Legend | [4 | | ize: 24,0 | • |
| | (pixels): 860 DP1 80 | Type: | filled : | Title: Font type: set | Arial | Legend mber of columns: Marker scale: | [4 [1,0 | | | • |
| | (pixels): 860 DP1 80 | Type: Colorset: | filled : jet | Title: Font type: | Arial | Legend | [4 [1,0 | | | 1 |
| | (pixels): 86 DP1 80 X Marker | Type: Colorset: Size: | filled : jet 10,5 | Title: Font type: | Arial | Legend mber of columns: Marker scale: | [4 [1,0 | | | • |
| T | (pixels): 860 DP1 80 | Type: Colorset: Size: | filled : jet 10,5 0,5 | Title: Font type: | Arial | Legend mber of columns: Marker scale: Font size: | [4 [1,0 [14,00 | | | 3 |
| T | (pixels): 86 DP1 80 X Marker | Type: Colorset: Size: | filled : jet 10,5 0,5 | Title: Font type: | Arial | Legend mber of columns: Marker scale: Font size: | [4 [1,0 | | | 3 |

- Step 6: Plot configuration. Choose the plot size, title, markers, time axis format, etc.
- *Step 7*: Save query results in different formats (.ods, .csv..).

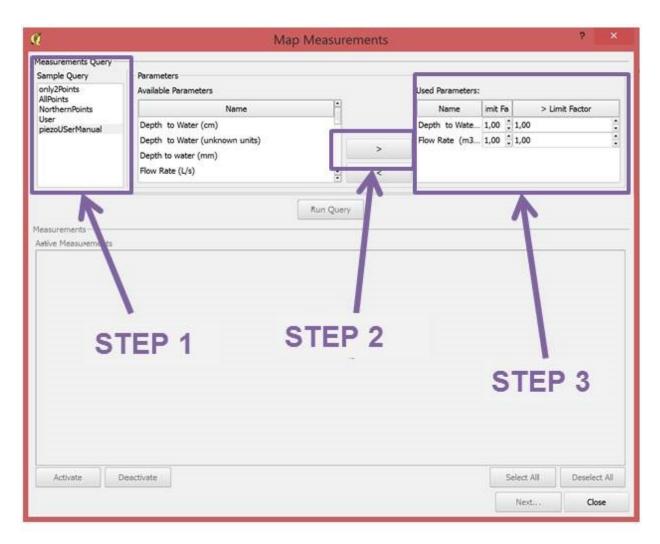


• *Step 8*: This button creates automatically time plots. The plot GUI, enable the user to save the plot in different formats, to pan axes, to zoom, to configure subplots and to save the plot in different formats such as .pdf, .png, .tiff, .svg, etc.

3.3 Hydrogeological Parameter Map



Use this command to create parameter plots of the selected query (created previously with the *Hydrogeological Spatial Query tool*, section 3.1) for the selected parameters.



- *Step 1*: Choose the Query created previously with the tool shown in section 3.1 (*Hydrogeological Spatial Query tool*).
- Step 2: Choose the parameter to be queried for the analysis.
- *Step 3*: Choose the limit factor to be applied to the censored values. With this tool the user has the option to substitute the censored values by this factor times the detection limits. The censored values are the parameter value reported as less than, < limit factor, or greater than, > limit factor.

| l – | | | Map Me | easurements | | | ? | × |
|--------------------------|----------|--|---|-------------------------|-------------------------------------|---|--------------|-----------|
| leasurement | ts Query | | | | | | | |
| Sample Quer | ry i | Parameters | | | | | | |
| only2Points AllPoints | | Available Parameters | | | Used Parameters: | | | |
| NorthernPoir | nts | | Name | - | Name | imit Fa | > Limit Fact | or |
| User piezoUSerMa | - | Depth to Water (cm) | | | Depth to Wate | 1,00 1,00 | | : |
| piezooberria | 00114400 | Depth to Water (unkno | own units) | | Flow Rate (m3 | 1,00 : 1,00 | | - |
| | | Depth to water (mm) | | > | | hoogenaan 688 beaaroneen | | |
| | | Flow Rate (L/s) | | | | | | |
| Active Measu | Point | Sample | Sample Date | Measurement Date | Parameter | Value | Unit | : Calcu |
| leasurement | | | | | | STER | - | |
| ctive Measu | irements | | | | | | _ | - |
| 100000 | Point | | | | | | Unit | : Calcu |
| × | P10 | - Internet in the Proof | | 2003-08-01 00:00:00.000 | Flow Rate (m3 | | m3/s | |
| × | P10 | | | 2003-08-02 00:00:00.000 | Flow Rate (m3 | and in the second se | m3/s | |
| X | P11 | | 2005-08-01 00:00:00.000 | | Flow Rate (m3 | 0.000 | m3/s | |
| X | P11 | and the state of t | and prove the property of the second s | 2005-08-01 00:00:00.000 | Contract and the second products of | | m3/s | 1 |
| × | P11 | - A start of the second start of the second | | 2005-08-02 00:00:00.000 | Flow Rate (m3 | /s) 20 | m3/s | 1 |
| | | STEP | 5 | | STI | EP 6 | 5 | |
| | K | <u> </u> | | | | 1 | | |
| | . Den | ctivate | | | | S. LA | I Des | elect All |
| Activate | | | | | | | | |
| Activate | Dea | 001759 | | | | _ | | |

- Step 4: Run Query.
- *Step 5*: Use this commands to activate or deactivated the desired measurements.
- Step 6: Click Next.

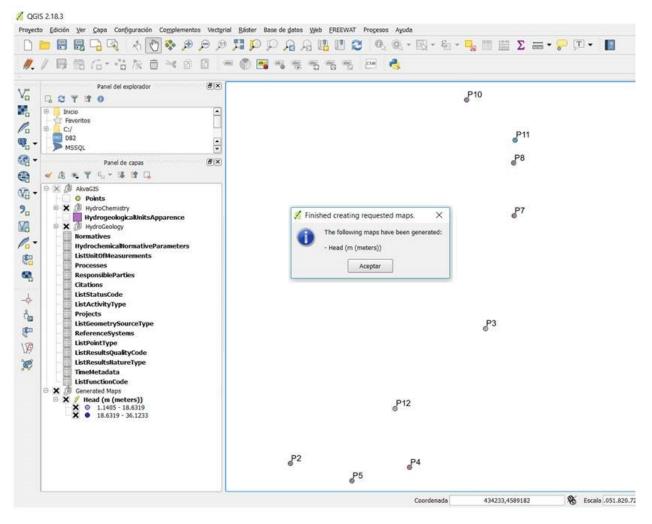
| New Kesult Samples PointId Point oordinate Sample Date Flow Rate (m3/s) (m3/s) 1 2 P10 432526 4,58998e headObs 2003-08 18 2 3 P11 433660 4,58904e headObs 2005-08 20 STEP 7 STEP 7 Value to use Earliest Latest | | | | | M | ap Resu | ılts | 8 | 3 |
|---|----|-------------|-------|-------------|-----------|---------|-----------------------|-------------------------|---|
| 1 2 P10 432526 4,58998e headObs 2003-08 18 2 3 P11 433660 4,58904e headObs 2005-08 20 STEP 7 STEP 7 Map settings Value to use | es | ult Samples | | | | | A. 11 | | _ |
| 2 3 P11 433660 4,58904e headObs 205-08 20 STEP 7 J | | PointId | Point | oordinate | oordinate | Sample | Date | Flow Rate (m3/s) (m3/s) | |
| STEP 7 | 1 | 2 | P10 | 432526 | 4,58998e | headObs | 2003-08 | 18 | |
| Map settings Value to use | 2 | 3 | P11 | 433660 | 4,58904e | headObs | 2005-08 | 20 | |
| | | | | | | | | | |
| | | | Ó | Earliest () | Latest ● | Average | Minimun Save Table | | e |

• *Step* 7: Map settings. Select the value to use in the map (earliest, latest, average, etc.)

STEP 8.1

| 9 | | | Save file | | | |
|---|--------|----------------|-------------|-----|----------------------------|-------|
| 🔄 🦻 • 🕇 📕 · | wp2 | ▶ UserManualTe | st7112015 × | ~ 6 | Buscar en UserManualTest71 | 12 P |
| Organizar * Nu | eva ca | rpeta | | |)III • | 0 |
| 3. Sitios recientes | ^ | Nombre | ^ | | Fecha de modificaci | Tipo |
| Este equipo Descargas Documentos Escritorio Imágenes Música Videos OS (C:) | | 1, bbdd | | | 07/11/2015 3:43 | Carpe |
| | * | ¢ | | | |) |
| Nombre: | userN | AanualTest | | | | ~ |
| Tipo: | Libre | Office (*.ods) | | | | ¥ |
| Ocultar carpetas | | | | | Guardar Cance | lar |

• Step 8.1: Save query results in different formats.



• Step 8.2: This button creates automatically parameter map.

3.4 Hydrogeological Units Maps

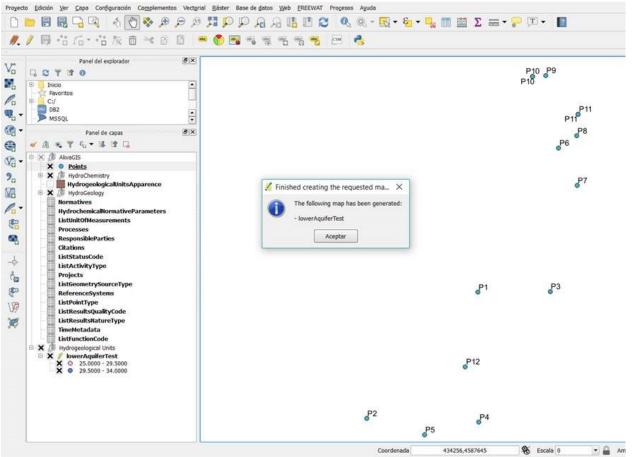
| Database Web | FREEWAT Processing Help | |
|--------------|---|---|
| Database Web | FREEWAT Processing Help Data-Preprocessing (akvaGIS) Model Setup MODFLOW Boundary Conditions Solute Transport Process Water Management and Crop Modeling (FARM PROCESS) Calibration/Sensitivity Tools DataBase Program Locations Run Model Post-processing OAT Image: About | Create AkvaGIS Database Open AkvaGIS Database Close AkvaGIS Database Close AkvaGIS Database Manage Hydrochemical Data Hydrochemical Spatial Query Piper Plot SAR Plot SBD Plot Stiff Plot Hydrochemical Parameters Time Plot Ionic Balance Report Chemical Parameter Map Parameter Normative Map Stiff Diagram Map EasyQuim Export ExcelMix Export StatQuimet Export |
| | OAT | Hydrochemical Parameters Time Plot Ionic Balance Report Chemical Parameter Map Parameter Normative Map Stiff Diagram Map EasyQuim Export |
| | | |

This command enables the user to create maps of top/bottom hydrogeological units defined in the wells.

| TED 4 | Unit: | lower aquifer of the Llobregat Delta lower aquifer of the Llobregat Delta | | |
|---------|-------------------|---|--|--|
| TEP 1 — | Description: | test aquiclude upper aquifer of the Llobregat Delta | | |
| | Туре: | aquifer | | |
| | Type Description: | It is a wet underground layer of water-bearing permeable rock or unconsolidated materials (gravel, sand. silt. or clay) from which | | |
| | Details: | | | |
| | Observations | | | |

- *Step 1*: Choose the hydrogeological unit that you want to query.
- Step 2: Create map for selected hydrogeological unit.





3.4.1 How to edit/add the top/bottom of a hydrogeological units?

To introduce a hydrogeological unit, *Wells*, *HydrogeologicalUnits* and *WellsHydrogeologicalUnits* tables are involved. To ensure a proper updated, the next workflow has to be done.

Select and open *Well* attribute table.

| X | Wells - Feature Attrib | utes | ? | × |
|-------------------|------------------------|------|----|-----------|
| id | 3 | | | \otimes |
| well | WellP11 | | | \otimes |
| pointId | | | | - |
| validFrom | P1 P10 | | | |
| validTo | P11 P12 | | | |
| lenght | P12 P2 P3 | | | |
| curb | P4 | | | |
| externalDiameter | Pb | | | |
| innerDiameter | P7 | | | • |
| constructionDate | 2016-07-24 15:15:13 | | | • |
| ownerId | | | | - |
| contructorId | | | | - |
| statusCode | | | | - |
| statusCodeDate | 2016-07-24 15:15:13 | | | - |
| activityType | | | | - |
| otherWellsDetails | NULL | | | |
| observations | NULL | | | |
| | | | | |
| | | ОК | Ca | ncel |

- *Step 1*: Introduce the general characteristic of the well that provide the information of the limits of the hydrogeological Unit (i.e. Top/bottom length of the Hydrogeological Unit). For further information about the database, please see AckvaGIS database documenttation section. In the *Wells* table, the following data are required:
 - Id Number: Unique identifier number.
 - Name well: Name of the well where hydrogeological unit is described.
 - *idPoint*: Unique identifier point name defined before in the *Points* table.
 - valid From: Start date when the well started to being used.
 - *valid To*: End date when the well ceased to being used. If this field is not fullfiled means that the well is still active.
 - *Length*: The distance along the well. This will be determined by the data provider (i.e., *length* can have different sources like drillers measurement loggers measurement survey).
 - curb: Distance from land to well curb (meters).
 - externalDiameter: Approximate Externe diameter (in mm).
 - innerDiameter: Approximate Interne diameter (in mm).
 - constructionDate: Date of Construction.
 - ownerId: Responsible party that owns the well.
 - contructorId: Party that carries out the development of the Well.

- *statusCode*: Values which describes the status of man-made hydrogeological objects.
- *statusCodeDate*: When was the last observation of the WellStatus.
- *activityType*: Type of activity carried out by the well.

Note: After update hydrogeological information, do not forget to save the edition session.

| id | 12 | 6 |
|-----------------------|------------------------------------|---|
| hydroUnit | shallowerAquifer | 6 |
| name | acuifero superficial | 6 |
| nameEN | shallower aquifer Manhattan System | 6 |
| description | NULL | |
| descriptionEN | NULL | |
| hydroUnitType | | |
| citationId | aquiclude aquifer | |
| otherHydroUnitsDetail | aquitard | |
| observations | NULL | |
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |

- *Step 2*: Edit or add a new hydrogeological Unit if is not included in the table *HydrogeologicalUnits*. Select and open the attribute table. Here, some information has to be added:
 - Id Number: Unique identifier number.
 - *HydroUnit*: Short name of the Hydrogeological Unit (unique).
 - *Name*: Full name of the aquifer in local language and *NameEN* field store the aquifer name in English (recommended).
 - *Description*: Description of the hydrogeological Unit in native language and *DescriptionEN* field store this information in English (recommended).
 - *hydroUnitType*: Type of hydrogeological Unit (Aquifer, Acuiclude, Aquitard). Further information about the hydrogeological units according to their classification in aquifers, aquicludes and aquitards will be introduced in further attributes tables (See chapter 4; Tables *Aquifers, Aquitards, Aquiclude* and *Aquifer System*). It is recommended to complete these tables as much as possible, even when they are not required for the use of the presented instruments.

- *CitationId*: Citation of the document where the normative is described. In case the citation is not in the list, add a new citation in the table *Citation* (from the TOC) (recommended).
- OtherHydroUnitDetails: Additional data (recommended).
- observations: Observations of the person that introduce the data into the database.(recommended)

Note: After update hydrogeological unit information, do not forget to save the edition session.

| 🧭 WellsHydrogeologicalU | nit - Feature Attributes 🛛 ? 🛛 🗙 |
|--------------------------------------|--------------------------------------|
| wellId | NULL |
| topLength | NULL |
| bottomLength | NULL |
| hydroUnitId | - |
| otherWellsHyrogeologicalUnitsDetails | test aquiciude |
| observations | upper aquifer of the Llobregat Delta |
| | |
| | |
| | |
| | |
| | |
| | |
| | |
| | |
| | |
| | |
| | |
| | OK Cancel |

- *Step 3*: Complete the required fields of the table *WellsHydrogeologicalUnits*. Select and open the attribute table. Here, some information has to be added:
 - WellId: Unique identifier of wells where the hydrogeological Units were observed.
 - *TopLenght*: Top of the depth described (in meters).
 - BottomLenght: Bottom of the depth described (in meters).
 - HydrogeologicalUnitId: Hydrogeological Unit defined along the well.
 - otherHydrogeologicalUnitsDetails: Additional data (recommended).
 - observations: Observations of the person that introduce the data into the database (recommended).

Note: After update wells hydrogeological units information, do not forget to save the edition session.

CHAPTER 4

Database documentation

- "*" Primary Key
- "**" Foreign Key
- Tables used in the Pre-processing tools (IDAEA CSIC)

4.1 Documentation of the project

The first step in the introduction of the data into AkvaDatabase is to describe the different documents, projects, campaigns or entities that provide the information. For entering the data in the AkvaDatabase, the user can use the utilities of Spatialite database or the utilities of QGIS.

4.1.1 Citations

In this table we introduce the information about the source of data. The source of data can be technical report, scientific papers, files, other databases, etc. This table acts as a library of terms, if the reference of the source of information (document, paper, etc.) that have been already included, you do not need to add a new term.

| NAME OF THE FIELD | DESCRIPTION | FORMAT |
|---------------------------|---|---------------|
| id* | Unique identifier for each citation | Integer; YES |
| citation | Citation is a human readable title and the publication date. e.g. Velasco2015Also | Text; 50; NO |
| | citationId for technical reports, names of databases, etc. E.g. GA2378297459EU | |
| title | Title of the report/paper/database etc | Text; 255; NO |
| alternateTitle | Short name or other language name by which the cited information is known. | Text; 50; NO |
| | Example: "DCW" as an alternative title for "Digital Chart of the World" | |
| description | Short description of the source of data in local language | Text; 255; NO |
| descriptionEN | Short description of the source of data in English | Text; 255; NO |
| presentationFormCode** | mode in which the resource is represented | Integer; YES |
| citedResponsiblePartyId** | name and position information for an individual or organization that is responsible | Integer; YES |
| | for the resource | |
| citationSearch | Document's location where it can be available and/or who can facilitate it). E.g. | Text; 255; NO |
| | file path in your computer | |
| citationDate | Date of edition/publication/revision of the document source of the data, date of | Date |
| | the last change of the database, date of the technical report | |
| otherCitationDetails | Additional data | Text; 255; NO |
| observations | Observations of the person that introduce the data into the database. | Text; 255; NO |

4.1.2 ResponsibleParties

This is the description of the organisation responsible for the establishment, management, maintenance and distribution of the resource. This description shall include the name of the organisation and a contact e-mail address. This table acts as a library, if the entity is already included, you do not need to add a new term.

| NAME OF THE FIELD | DESCRIPTION | FORMAT |
|------------------------------|--|---------------|
| id* | Unique identifier for each responsable party | INTEGER; YES |
| responsibleParty | Unique name for each entity (laboratory, company, employees, etc.). E.g. For | Text; 50; YES |
| | Technical University of Catalonia, ResponsiblePartyId can be UPC | |
| individualName | name of the responsible personsurname, given name, title separated by a delimiter | Text; 255; NO |
| organisationName | name of the responsible organization | Text; 255; NO |
| positionName | role or position of the responsible person | Text; 255; NO |
| deliveryPoint | address line for the location (as described in ISO 11180, Annex A) | Text; 255; NO |
| city | city of the location | Text; 255; NO |
| administrativeArea | state, province of the location | Text; 255; NO |
| postalCode | ZIP or other postal code | Text; 255; NO |
| Country | country | Text; 255; NO |
| electronicMailAddress | address of the electronic mailbox of the responsible organization or individual | Text; 255; NO |
| Phone | telephone numbers at which the organization or individual may be contacted | Text; 255; NO |
| onlineResource | on-line information that can be used to contact the individual or organization | Text; 255; NO |
| Linkage | location (address) for on-line access using a Uniform Resource Locator address | Text; 255; NO |
| | or similar addressing scheme such as http://www.statkart.no/isotc211URL (IETF | |
| | RFC1738 IETF RFC 2056) | |
| Protocol | connection protocol to be used | Text; 255; NO |
| applicationProfile | name of an application profile that can be used with the online resource | Text; 255; NO |
| onlineResourceName | name of the online resource | Text; 255; NO |
| Description | detailed text description of what the online resource is/does | Text; 255; NO |
| functionCode** | Code for function performed by the online resource. From the table ListFunction- | INTEGER; NO |
| | Codes | |
| hoursOfService | time period (including time zone) when individuals can contact the organization | Text; 255; NO |
| | or individua | |
| contactInstructions | supplemental instructions on how or when to contact the individual or organization | Text; 255; NO |
| otherResponsiblePartyDetails | Additional data | Text; 255; NO |
| Observations | Observations of the person that introduce the data into the database | Text; 255; NO |

4.1.3 Projects

This table allows the user to introduce information about the project that provides the information. This table acts as a library, if the project is already included, you do not need to add a new term.

| NAME OF THE FIELD | DESCRIPTION | FORMAT |
|---------------------------|--|---------------|
| id* | Project's Unique identifier | INTEGER; YES |
| project | Project's Unique identifier name. E.g. PANACEA | Text; 50; NO |
| name | Project's full Name | Text; 200; NO |
| description | Short description of the project in local language | Text; 255; NO |
| descriptionEN | Short description of the project in English | Text; 255; NO |
| citationId** | Reference of the document that contains the agreement, proposal, etc. | INTEGER; NO |
| principalInvestigatorId** | Key party responsible for gathering information and conducting research of this | INTEGER; NO |
| | project. | |
| parentProject | The parent Project. A large investigation project may have several sub projects. | Text; 255; NO |
| otherProjectDetails | Additional data | Text; 255; NO |
| observations | Observations of the person that introduce the data into the database | Text; 255; NO |

4.1.4 Campaigns

This table contains details about the campaign (e.g. hydrochemical campaign) performed to obtain the data. This table acts as a library, if the campaign is already included, you do not need to add a new term.

| NAME OF THE FIELD | DESCRIPTION | FORMAT |
|----------------------|---|---------------|
| id* | Unique identifier for each field campaign | INTEGER; YES |
| campaign | Name of the Unique identifier for each field campaign. E.g.Campaign01 | Text; 50; NO |
| campaignType** | Type of a campaign must be one of the item listed in ListCampaignType | INTEGER; NO |
| projectId** | Unique identifier for each project related with the field campaign | INTEGER; NO |
| beginDate/endDate | Start/End date of the campaign | Date; NO |
| clientId** | Party to which investigation is carried out | INTEGER; NO |
| custodianId** | Party responsible to maintain data related to the campaign | INTEGER; NO |
| dataOwnerId** | Responsible party that owns the data related to the campaign. | INTEGER; NO |
| contractorId** | Party that carries out the survey | INTEGER; NO |
| otherCampaignDetails | Additional data | Text; 255; NO |
| observations | Observations of the person that introduce the data into the database | Text; 255; NO |

4.2 Geography/general data

These tables contain information about the location of the points of interest (i.e. of the observed feature such as wells, springs, sea...)

4.2.1 Points

This is a geometric feature (point) that represents points where hydrogeological observations have been done.

| NAME OF THE FIELD | DESCRIPTION | FORMAT |
|--|--|-----------------|
| id* | unique identifier for each point with information | INTEGER; YES |
| point | Name of the unique identifier for each point with information | Text; 50; YES |
| beginLifespanVersion | Specifies the date and time at which this version of the spatial object was inserted or changed in the spatial data set (INSPIRE) | Date |
| endLifespanVersion | Specifies the date and time at which this version of the spatial object was super- seded or retired in the spatial data set. If the endLifespanVersion is null, this indicates that the object is the current representation of the feature(INSPIRE) | Date |
| name | Place name of the point (popular name of the point, e.g. Well of the Major, Spring of the butterflies?) | Text; 100; NO |
| name2/name3/name4 | Point's name in different databases or references. Note that the same point can provide different information of different nature and origin and can be termed with different names in different reports | Text; 100; NO |
| description | Text providing description of object | Text; 255; NO |
| cooX | Coordinate X | Double; YES |
| cooY | Coordinate Y | Double; YES |
| elevation | Elevation (Z) in meters | Double; NO |
| geometryCooSourceType** | Type of CooX, CooY (e.g. BoreholeO&M, cartographicalO&M) ListGeome- trySourceType | INTEGER; NO |
| geometryElevationSourceType** | Type of source of the geometry of Elevation (e.g. BoreholeO&M, Cartograph- icalO&M) ListGeometrySourceType | INTEGER; NO |
| elevationReferenceSystemId** | reference System of the Elevation | INTEGER; NO |
| cooReferenceSystemId** | reference System of the coordinators X, Y | INTEGER; NO |
| sourceReferenceSystemId** | spatial reference system used by the source data | INTEGER; NO |
| nameCita- | Reference of the name indicated in Nam1-4Point. Here introduce the reference of | INTEGER; |
| tion/name2Citation/name3Citation/name4Citation** | the report/database were the information point were obtained | NO |
| adressPoint | Adress of the point of interest (e.g. Palm Beach, 92, Cuenca) | Text; 255; NO |
| accessPoint | Description of the access to the point (e.g. easy access, it is in the middle of the street, talk to the owner, its unknown). In any case the information has to be accompanied with the date | Text; 255; NO |
| pointType** | Type of point (spring, seep, swallowHole, well, seepoint, lakepoint) | INTEGER; NO |
| otherPointDetails | Additional data | Text; 255; NO |
| observations | Observations of the person that introduce the data into the database | Text; 255; NO |

4.2.2 ReferenceSystems

This package contains the identification of the spatial and temporal reference system(s) used in a dataset. This table act as a library, if the reference system code already exist in this you do not need to fill this table.

| NAME OF THE FIELD | DESCRIPTION | FORMAT |
|-----------------------------|---|----------------|
| id* | Unique identifier for each reference system | INTEGER; YES |
| referenceSystem | Refer to ISO 19111 when coordinate system is not given through reference system | Text; 255; YES |
| | identifier | |
| name | name of the reference system used in the local language | Text; 255; NO |
| nameEN | name of the reference system used in English | Text; 255; NO |
| domainOfValidity | range which is valid for the reference system | Text; 255; NO |
| OtherReferenceSystemDetails | additional details | Text; 255; NO |
| observation | Observations of the person that introduce the data into the database | Text; 255; NO |

4.3 Hydrogeological objects

4.3.1 HydrogeologicalUnits

The INSPIRE hydrogeological data model considers 3 areas: Hydrogeological Units (e.g. Aquifers, Aquitards and aquiclude). Hydrogeological Systems and man-made and natural objects wich interact with those systems. The HydrogeologicalUnits stores the conceptual description and attributes of the hydrogeological units identified. A hydrogeological unit is a part of the terrain with distinct parameters for water storage and conduction. There are 3 main subclasses of hydrogeological units: Aquifer, Aquitard and Aquiclude. This table act as a library, if the Hydrogeological Unit has been already included, you do not need to add a new term.

| NAME OF THE FIELD | DESCRIPTION | FORMAT |
|------------------------|--|---------------|
| id* | Unique identifier for each hydrogeological unit | INTEGER; YES |
| hydrogeologicalUnit | Name of the Unique identifier for each hydrogeological unit | Text, 50; NO |
| | (e.g.UpperAquiferLlobregat) | |
| name | Name of the hydrogeological Unit in the local language | Text; 255; NO |
| nameEN | Name of the hydrogeological Unit in English. | Text; 255; NO |
| description | Short description of the hydrogeological Unit in local language | Text; 255; NO |
| descriptionEN | Short description of the hydrogeological Unit in English | Text; 255; NO |
| hydroUnitType** | Type of hydrogeological unit (aquifer, aquitar or aquiclude) | INTEGER; NO |
| citationId** | Document containing information about this Hydrogeological Units | INTEGER; NO |
| otherHydroUnitsDetails | Additional data | Text; 255; NO |
| observations | Observations of the person that introduce the data into the database | Text; 255; NO |

4.3.2 HydrogeologicalUnitsApparence

The hydrogeological units have different spatial representations in 2D.

| NAME OF THE FIELD | DESCRIPTION | FORMAT |
|---------------------------|--|---------------|
| id* | Unique identifier for each hydrogeological unit apparence | INTEGER; YES |
| hydrogeologicalUnitId** | Unique identifier for each hydrogeological unit | INTEGER; YES |
| approximateDepth | Approximate depth (mean value) of the hydrogeological unit | Double |
| approximateThickness | Approximate thickness (mean value) of the hydrogeological unit | Double |
| beginLifespanVersion | Stores the date that the new object was created | Date; NO |
| endLifespanVersion | The date that the next version of the object was created. If the endLifespanVersion | Date; NO |
| | is null, this indicates that the object is the current representation of the feature | |
| sourceReferenceSystemId** | spatial reference system used by the source data | INTEGER; NO |
| referenceSystemId** | reference System of the Aquifer | INTEGER; NO |
| geometrySourceType** | The type of source for the geometry of a hydrogeological feature. | INTEGER; NO |
| observations | Observations of the person that introduce the data into the database | Text; 255; NO |

4.3.3 Aquifers

This table store the properties of the Hydrogeological Units defined as Aquifers. An Aquifer is a wet underground layer of water-bearing permeable rock or unconsolidated materials (gravel, sand, silt, or clay) from which groundwater can be usefully extracted by a groundwater well. (INSPIRE).

| NAME OF THE FIELD | DESCRIPTION | FORMAT |
|----------------------------------|--|---------------|
| id* | Unique Identifier for each aquifer | INTEGER; YES |
| aquifer | name for each Unique Identifier ofeach aquifer | Text; 50: NO |
| hydrogeologicalUnitId** | name of Unique Identifier for each aquifer defined in the table HydrogeologicalU- nit E.g. e.g. UpperAquiferLlobregat | INTEGER; YES |
| name | Aquifer's name in the local language | Text; 255; NO |
| nameEN | Aquifer's name in English | Text; 255; NO |
| aquiferType** | Water in an Aquifer is, or is not, under pressure. Based on those unconfined, confined, artesian, or subartesian types are distinguished. Further information in INSPIRE data specifications | INTEGER; NO |
| mediaType** | The classification of the medium in which the groundwater flow occurs | INTEGER; NO |
| isExploited | Indicates if groundwater from aquifer is exploited by wells or intakes | boolean |
| isMainInSystem | Indicates if aquifer is the main useful aquifer in the aquifer system | boolean |
| permeabilityCoefficient | The volume of an incompressible fluid that will flow in unit time through a unit cube of a porous substance across which a unit pressure difference is maintained. The parameter represents the hydraulic conductivity of a rock container. Describes the ease with which water can move through pore spaces or fractures. It depends on the intrinsic permeability of the material and on the degree of saturation. NOTE: Because of their high porosity and permeability, sand and gravel have higher hydraulic conductivity than clay or unfractured granite aquifers.NOTE OF THE AUTHORS: This should be a mean value. The aquifers media is heterogeneous | Double; NO |
| permeabilityCoefficientUomCode** | Unit of measurement of permeability coefficient | INTEGER; NO |
| storativityCoefficient | The ability of an aquifer to store water. NOTE OF THE AUTHORS: This should be a mean value. The aquifers media is heterogeneous | Double;NO |
| vulnerabilityPollution | An index value or interval of values determining the potential degree of aquifer risk arising from the geological structure, hydrogeological conditions and the existence of real or potential source of contamination. A single value should be used if it is determined directly from the DRASTIC method. If attribute data comes from another data source which is expressed by categorized items, for example: low, moderate or high, interval should be used expressed by lowest and highest value of category. EXAMPLE: Moderate means interval from 101 to 140.(INSPIRE) | Text; 255; NO |
| hydroGeochRockType** | The rock type with respect to the soluble rock components and their hydro- geochemical influence of groundwater. Defines the prevailing geochemical character of natural groundwater within the Aquifer. Further information in http://inspire.ec.europa.eu/codeList/HydroGeochemicalRockType | INTEGER; NO |
| aquiferSystemId** | The AquiferSystem of which the Aquifer is a part | INTEGER; NO |
| otherAquiferDetails | Additional data | Text; 255; NO |
| observations | Observations of the person that introduce the data into the database | Text; 255; NO |

4.3.4 Aquitards

This table store the properties of the Hydrogeological Units defined as Aquitards. It does not yield water freely to wells, but may transmit appreciable water to or from adjacent aquifers and, where sufficiently thick, may constitute an important ground-water storage unit. Aquitards are characterized by values of leakance that may range from relatively low to relatively high. A really extensive aquitard of relatively low leakance may function regionally as boundaries of aquifer flow systems (INSPIRE).

| NAME OF THE FIELD | DESCRIPTION | FORMAT |
|------------------------------------|--|---------------|
| id* | Unique Identifier for each aquitard | INTEGER; YES |
| aquitard | name of the unique identifier for each aquitard | Text; 50: NO |
| hydrogeologicalUnitId** | Unique Identifier for each aquitard defined in HydrogeologicalUnits | INTEGER; YES |
| name | Aquitard's name in the local language | Text; 255; NO |
| nameEN | Aquitard's name in English | Text; 255; NO |
| IdHydroGeochRockType** | The rock type with respect to the soluble rock components and their hydrogeo- | INTEGER; NO |
| | chemical influence of groundwater. Defines the prevailing geochemical character | |
| | of natural groundwater within the Aquifer. NOTE OF THE AUTHORS: This | |
| | should be a mean value. The aquifers media is heterogeneous | |
| approximatepermeabilityCoefficient | The volume of an incompressible fluid that will flow in unit time through a unit | Double; NO |
| | cube of a porous substance across which a unit pressure difference is maintained. | |
| | The parameter represents the hydraulic conductivity of a rock container. Describes | |
| | the ease with which water can move through pore spaces or fractures. It depends | |
| | on the intrinsic permeability of the material and on the degree of saturation. | |
| | NOTE: Because of their high porosity and permeability, sand and gravel have | |
| | higher hydraulic conductivity than clay or unfractured granite aquifers | |
| permeabilityCoefficientUomCode** | Unit of measurement of permeability coefficient | INTEGER; NO |
| approximatestorativityCoefficient | The ability of an aquifer to store water. NOTE OF THE AUTHORS: This should | Double; NO |
| - | be a mean value. The aquifers media is heterogeneous | |
| aquiferSystemId** | The AquiferSystem of which the Aquitard is a part | INTEGER; NO |
| Observations | Additional data | Text; 255 ;NO |
| ObsInput | Observations of the person that introduce the data into the database | Text; 255; NO |

4.3.5 Aquicludes

This table store the properties of the Hydrogeological Units defined as Aquiclude. It is a formation which, although porous and capable of absorbing water slowly, will not transmit water fast enough to furnish an appreciable supply for a well or spring. Aquicludes are characterized by very low values of "leakage" (the ratio of vertical Hydraulic Conductivity to thickness), so that they transmit only minor inter-aquifer flow and also have very low rates of yield from compressible storage. Therefore, they constitute boundaries of aquifer flow systems (INSPIRE).

| NAME OF THE FIELD | DESCRIPTION | FORMAT |
|-------------------------|--|---------------|
| id* | Unique Identifier for each aquiclude | INTEGER; YES |
| hydrogeologicalUnitId** | Unique Identifier for each aquiclude defined in the table defined in Hydrogeologi- | INTEGER; YES |
| | calUnits | |
| name | Aquiclude's name in the local language | Text; 255; NO |
| nameEN | Aquiclude's name in English | Text; 255; NO |
| hydroGeochRockType** | The rock type with respect to the soluble rock components and their hydrogeo- | INTEGER; NO |
| | chemical influence of groundwater. Defines the prevailing geochemical character | |
| | of natural groundwater within the Aquifer | |
| aquiferSystemId** | The AquiferSystem of which the Aquitard is a part | INTEGER; NO |
| otherAquicludeDetails | Additional data | Text; 255; NO |
| observations | Observations of the person that introduce the data into the database | Text; 255; NO |

4.3.6 AquiferSystems

A collection of aquifers and aquitards, which together constitute the environment of groundwater - "communicating vessels", that are filled or can be filled with water. Attributes of Aquifer System and its components determine the feasibility of water collection, its movement, as well as the impact on its chemical state. NOTE: The Aquifer System components and their attributes (including geometry) are relatively stable over time except in special cases.

| NAME OF THE FIELD | DESCRIPTION | FORMAT |
|---------------------------|--|---------------|
| id* | Unique Identifier for each aquifer system | INTEGER; YES |
| aquiferSystem | name of Unique Identifier for each aquifer system | Text; 50: NO |
| name | AquferSystem's name in the local language | Text; 255; NO |
| nameEN | AquiferSystem's name in English | Text; 255; NO |
| isLayered | Indicates if the AquiferSystem consists of more than one layer. | boolean |
| otherAquiferSystemDetails | Additional data | Text; 255; NO |
| observations | Observations of the person that introduce the data into the database | Text; 255 ;NO |

4.3.7 Wells

This table store the main attributes of the wells.

| NAME OF THE FIELD | DESCRIPTION | FORMAT |
|-------------------|--|---------------|
| id* | Unique identifier for each well | INTEGER; YES |
| pointId** | Unique identifier for each point with information. | INTEGER; YES |
| well | name of the Unique identifier for each well | Text; 50: YES |
| validFrom | The date the well started being used | Date |
| validTo | The date the well ceased being used. If this field is not fullfiled means that the | Date |
| | well it is still active | |
| lenght | The distance along the well. This will be determined by the data provider (ie, | Double; NO |
| | "length"" can have different sources like drillers measurement loggers measure- | |
| | ment survey)" | |
| curb | Distance from land to well curb (meters) | Double; NO |
| externalDiameter | Approximate Externe diameter (in mm) | Double; NO |
| innerDiameter | Approximate Interne diameter (in mm) | Double; NO |
| constructionDate | Date of Construction | Date; NO |
| ownerId** | Responsible party that owns the well | INTEGER; NO |
| contructorId** | Party that carries out the development of the Well | INTEGER; NO |
| statusCode** | Values describing the status of man-made hydrogeological objects | INTEGER; NO |
| statusCodeDate | When was the last observation of the WellStatus | Data; NO |
| activityType** | The type of activity carried out by the well. | INTEGER; NO |
| otherWellsDetails | Additional data | Text; 255; NO |
| observations | Observations of the person that introduce the data into the database | Text; 255; NO |

4.3.8 WellsHydrogeologicalUnit

This table store the definition of the boundaries of the different hydrogeological units identified for each well.

| NAME OF THE FIELD | DESCRIPTION | FORMAT |
|----------------------------------|--|---------------|
| wellId** | Unique identifier of wells where the hydrogeological units were observed | INTEGER; YES |
| top/bottomLength | Top and the bottom of the depth described (in meters) | Double; YES |
| hydrogeologicalUnitId** | HydroUnits defined/identified along the well (defined in the table Hydrogeologi- | INTEGER; YES |
| | calUnits) | |
| otherWellsHyrogeologicalUnitsDe- | Additional data | Text; 255; NO |
| tails | | |
| observations | Observations of the person that introduce the data into the database | Text; 255; NO |

4.3.9 Screens

In this table the main characteristics of the screens of the wells can be introduced. This table acts as a library, if the screen is already included, you do not need to add a new term.

| NAME OF THE FIELD | DESCRIPTION | FORMAT |
|----------------------|---|---------------|
| Id* | Unique identifier for the screen installed in the wells/piezometers | INTEGER; YES |
| screen | name of the unique identifier for the screen installed in the wells/piezometers | Text; 50; NO |
| responsiblePartyId** | Model Entity | INTEGER; NO |
| screenType** | ScreenType from the ListScreenType(e.g. Slotted Plastic Pipe, continuous-slot | INTEGER; NO |
| | screen) | |
| description | Short description in the local language of the screen | Text; 255; NO |
| descriptionEN | Short description of the screen in English | Text; 255; NO |
| OtherScreenDetails | Additional data | Text; 255; NO |
| observations | Observations of the person that introduce the data into the database | Text; 255; NO |

4.3.10 WellScreens

This table has been designed to contain the screen type and the intervals screened. It also establishes (for each screened interval) the link of the well to the hydrogeological unit that is screened. Thus, a well can be screened in diverse hydrogeological units whereas a hydrogeological unit can be screened by different wells.

| NAME OF THE FIELD | DESCRIPTION | FORMAT |
|--------------------------|--|---------------|
| wellId** | Unique identifier for each well | INTEGER; YES |
| screenId** | Unique identifier for the screen installed in the wells | INTEGER; YES |
| topLenght | Length of the top of the Screen (in meters) | Double; NO |
| bottomLenght | Length of the bottom of the Screen (in meters). | Double; NO |
| screenExtentCode** | Extent of the screen in the hydrogeological unit (partial, entire, etc.) | INTEGER; YES |
| instalationDate | Date of installation | Date;NO |
| hydrogeologicalUnitsId** | Hydrogeological unit that is screened | INTEGER; YES |
| otherWellScreensDetails | Additional data | Text; 255; NO |
| Observations | Observations of the person that introduce the data into the database | Text; 255; NO |

4.3.11 Springs

| NAME OF THE FIELD | DESCRIPTION | FORMAT |
|---------------------------------------|---|---------------|
| Id* | Unique identifier for spring | INTEGER; YES |
| pointId** | Unique identifier for each point | INTEGER; YES |
| springType** | SpringType | Text; 50; NO |
| persistenceCode | The degree of persistence of water flow.E.g . Inter- mittent, seasonal, perennial, notSpecified ephemeral, http://inspire.ec.europa.eu/codeList/WaterPersistenceValue | INTEGER; NO |
| approximateQuantityOfFlow | An approximate value defining the water yield in a natural hydrogeological object | Double; NO |
| approximateQuantityOfFlowUom- Code | Units of measurements of the quantity of flow | INTEGER; NO |
| description | Short description in the local language of the spring | Text; 255; NO |
| waterPersistenceCode descriptionEN | Short description of the spring in English | Text; 255; NO |
| OtherSpringDetails | Additional data | Text; 255; NO |
| observations | Observations of the person that introduce the data into the database | Text; 255; NO |

4.4 Hydrogeological observations and measurements

The HydrogeologicalPointsObservations and HydrogeologicalPointsMeasurements tables were designed to manage hydrogeological data observed at a given groundwater point such as time series of head measurements, or rate and volume of abstraction or recharge .The aforementioned tables related to the temporal measurements (TimeMetadata) and to the process used to carry out the observation (Processes) are linked to these tables. A code list of hydrogeological measurements with its corresponding units (ListHydrogeologicalParametersCode) was also developed.

4.4.1 HydrogeologicalPointsObservations

This table store information of the hydrogeological data observed at a given groundwater point (e.g. well abstraction, water level, etc.).

| NAME OF THE FIELD | DESCRIPTION | FORMAT |
|---------------------------------|---|---------------|
| Id* | Unique identifier for each observations/measurements performed for each ground- | INTEGER; YES |
| | water point defined | |
| pointId** | Unique identifier for each point with groundwater information (based on | INTEGER; YES |
| | O&M:FeatureOfInterest) | |
| hydrogeologicalParametersCode** | This property is used to describe the phenomenon that is being observed (including | INTEGER; YES |
| | the uom) (based on O&M: observed property) | |
| qualifier | Define potentially influential conditions occurring whilst the measurement was | Text; 50; NO |
| | taking place (after WTDF). E.g. pumping ocurring | |
| processId** | Unique identifier for each process used to carry out the observation (based on | INTEGER; NO |
| | O&M:Procedure) | |
| phenomenomTime | This may be the time when the observation procedure was performed on a real- | Data |
| | world feature (based on O&M:phenomenomTime) | |
| timeMetadataId** | Unique identifier for each characteristic time-series | INTEGER; NO |
| beginDate | Start time period, defining the start and end times of the time series (after WaterML | Date/Hour |
| | 2.0) | |
| endDate | End time period, defining the start and end times of the time series (after WaterML | Date/Hour |
| | 2.0) | |
| citationId** | Reference of the source of information | INTEGER; NO |
| responsiblePartyId** | Unique identifier for the person/entity in charge of the measurement | INTEGER; NO |
| resultsQualityCode** | This is used to describe the overall quality of a time series. Time series often | INTEGER; NO |
| | require per point quality information, which is provided by the specific time-series | |
| | types that are used | |
| resultsNatureType** | Nature of the results (e.g. simulated) | INTEGER; NO |
| otherObservationsDetails | Additional data | Text; 255; NO |
| Observations | Observations of the person that introduce the data into the database | Text; 255; NO |

4.4.2 HydrogeologicalPointsMeasurements

This table store the information related to the hydrogeological data observed at a given groundwater point such as time series of head measurements, or rate and volume of abstraction or recharge.

| NAME OF THE FIELD | DESCRIPTION | FORMAT |
|-------------------------------|---|----------------|
| hydroPointObsId** | Unique identifier for each observations/measurements performed for each ground- | INTEGER; YES |
| | water point defined | |
| resultTime | The attribute resultTime describes the time when the result became available, typi- | Date/hour; YES |
| | cally when the procedure associated with the observation was completed For some | |
| | observations this is identical to the phenomenonTime (based on O&M:resultTime) | |
| value | The value is a Record that indicates the value of the property of interest for the | Double; YES |
| | observation. (based on O&M:values) | |
| qualifier | Property of the value. E.g. > , </td <td>Text; 10; NO</td> | Text; 10; NO |
| otherHydroMeasurementsDetails | Additional data | Text; 255; NO |
| observations | Observations of the person that introduce the data into the database | Text; 255; NO |

4.4.3 TimeMetadata

This table contains details of the time series obtained in the observation point.

| NAME OF THE FIELD | DESCRIPTION | FORMAT |
|--------------------------|--|---------------|
| Id* | Unique identifier for each characteristic time-series. Describe the time-serie | INTEGER; YES |
| accuracy | This property allows for a quantitative assertion of the estimated accuracy of the | Double; NO |
| | measurement value (e.g. Standard Deviation) | |
| spacing | The spacing property of the time series is used to specify the time between points | Double; NO |
| interpolationType** | One of the core characteristics of measurement time series is the nature of the | INTEGER; NO |
| | relationship between the time instant and the recorded value. This relationship | |
| | is determined by the procedure that was used in making the estimate that the | |
| | value represents. WaterML2.0 defines a number of types of time series. (e.g. | |
| | Continuous, Average in preceding interval,) | |
| nilReasonCode** | This property describes the reason that a point has been identified as null. This | INTEGER; NO |
| | provides context for interpreting null points (e.g. missing, withheld etc.). Further | |
| | information in WML2.0. | |
| otherTimeMetadataDetails | Additional data | Text; 255; NO |
| observations | Observations of the person that introduce the data into the database | Text; 255; NO |

4.4.4 Processes

It has the role of describing generic procedures that are common in practice and can be referenced from many observations that were made in the same or similar way. It has name, unique identifier, documentation, responsibleParty to inform the user about the nature of the procedure and the authority that maintains the record.

| NAME OF THE FIELD | DESCRIPTION | FORMAT |
|------------------------|---|---------------|
| Id* | Unique Identifier for each type of process used | INTEGER; YES |
| name | Name of the process used for performing the measurement, the sampling, etc. in | Text; 50; NO |
| | the local language | |
| nameEN | Name of the process used for performing the measurement in English | Text; 50; NO |
| description | Short description of the process in the local language | Text; 255; NO |
| descriptionEN | Short description of the process in English | Text; 255; NO |
| responsiblePartyId** | Responsible party to the user about the nature of the procedure and the authority | INTEGER; NO |
| | that maintains the record | |
| processParameterCode** | Generic process parameter | INTEGER; NO |
| processType** | Process Used type | INTEGER; NO |
| citationId** | Documentation of the process used | INTEGER; NO |
| otherProcessDetails | Additional data | Text; 255; NO |
| oservations | Observations of the person that introduce the data into the database | Text; 255; NO |

4.5 Hydrochemical observations and measurements

The hydrogeochemical data from each sampling point are stratified within the database in accordance with the sampling point, campaign, sampling date, name and lenght (in HydrochemicalSamples). Thereafter, each sample is stratified in accordance with sampling data analysis, parameter, value and measurement units (in HydrochemicalMeasurement). The different observed properties (physico-chemical parameters) are included in a codelist termed ListHydroChemicalParameters.

4.5.1 HydrochemicalSamples

This table store the main properties of the samples to be analysed.

| NAME OF THE FIELD | DESCRIPTION | FORMAT |
|------------------------|--|---------------|
| pointId** | Unique identifier for each point where the sample has been taken (pointId from | INTEGER; NO |
| | Points). In the O&M:The sampledFeature is the feature the SamplingFeature was | |
| | sampled from, providing the ultimate context for the observation. An example | |
| | of sampledFeature would be the river segment a specimen was taken from.In the | |
| | O&M schema also the FoI is modelled as a SF_Specimen; the location pertaining | |
| | to the measurement is provided by the attribute samplingLocation | |
| samplingTime | Date of sample collection | Date; YES |
| Id | Unique identifier for each sample. In the O&M standard it is correspond with | INTEGER; YES |
| | Specimen. A specimen is a feature sampled from a feature of interest to enable | |
| | ex-situ observation, such as in a laboratory | |
| sample | Unique name/identifier for each sample | Text; 50; YES |
| campaignId** | Unique identifier for the campaign in which the sample was taken. CampaignId | TINTEGER; NO |
| | from campaigns; campaignId | |
| fieldName | Name of the sample in the field before to send to the lab | Text; 30; NO |
| currentLocation | If present, the attribute currentLocation: Location shall describe the location of a | Text; 50; NO |
| | physical specimen. This may be a storage location, such as a shelf in a warehouse | |
| | or in a laboratory | |
| sampleSize | Size of the sample. Measure shall describe a physical extent of the specimen. | Double; NO |
| | This may be volume | |
| sampleSizeUom | Unit of measurement (vol) of the sample Size | Text; 50; NO |
| sampleLenght | Lenght/Depth where sample was obtained (m) | Double; NO |
| samplingMethodId | The attribute samplingMethodId shall describe the method used to obtain the | INTEGER; NO |
| | specimen | |
| samplingTime | The time the sample was taken. (based on O&M scheme) | Data |
| responsablePartyId** | Person /entity responsible of the sample collection | TINTEGER; NO |
| otherChemSampleDetails | Additional data | Text; 255; NO |
| observations | Observations of the person that introduce the data into the database | Text; 255; NO |

4.5.2 HydrochemicalMeasurements

This table store the measurement of the aforementioned samples.

| NAME OF THE FIELD | DESCRIPTION | FORMAT |
|--------------------------------|--|---------------|
| sampleId** | Unique identifier for each sample defined in HydrochemicalSamples | TINTEGER; YES |
| hydrochemicalParametersCode ** | Unique Identify for each parameter from ListHydroChemicalParameters; | TINTEGER; NO |
| | field:parameterId | |
| resultTime | Provides the time the results of the laboratory analysis were made available. If | Date; NO |
| | the measurement was done in situ, resultTime is equal to samplingTime (table | |
| | HydrochemicalSamples) | |
| value | Result, numeric value | Doble; NO |
| compValue | censored values (which are the concentrations of some elements reported as | Text; 50; NO |
| | non-detected?, or as less-than? or greater-than?) | |
| responsablePartyId** | Laboratory from ResponsibleParties where the sample was analyzed. If the | INTEGER; NO |
| | measurement was done in situ, here the author of such measurement | |
| processId** | Procedure of the analysis | INTEGER; NO |
| citationId** | Citation to the laboratory report. From the table Citations | TINTEGER; NO |
| otherChemMeasurementDetails | Additional data | Text; 255; NO |
| observations | Observations of the person that introduce the data into the database | Text; 255; NO |

4.5.3 Normatives

This table store information of the different regulatory guideline. This table acts as a library, if the normative/guideline details are already included, you do not need to add a new term.

| NAME OF THE FIELD | DESCRIPTION | FORMAT |
|-----------------------|---|---------------|
| Id* | Unique identifier for each normative, directive, etc. | INTEGER; YES |
| responsiblePartyId** | Entity/Agency/ organism that has developed (or applied) the normative | INTEGER; NO |
| name | Name of regulations, guidelines, etc. in the local language | Text; 50; NO |
| nameEN | Name of regulations, guidelines, etc. in English | Text; 50; YES |
| date | Date of regulations, guidelines, etc. | Date; NO |
| citationId | Documentation of the normative | INTEGER; NO |
| otherNormativeDetails | Additional data | Text; 255; NO |
| observations | Observations of the person that introduce the data into the database | Text; 255; NO |

4.5.4 HydrochemicalNormativeParameters

This table acts as a library, if the normative/guideline details for a given parameter are already included, you do not need to add a new term.

| NAME OF THE FIELD | DESCRIPTION | FORMAT |
|--------------------------------|---|---------------|
| normativeId** | Unique identifier for each normative, directive, etc. | INTEGER; |
| | | YES |
| hydrochemicalParametersCode ** | Unique Identify for each parameter from ListHydroChemicalParameters; | INTEGER; |
| | field:parameterId (the uom is included into the code) | YES |
| parameterNormativeName | Unique Identifier/name for each parameter defined by the normative/guideline | Text; 50; NO |
| | (e.g. Nitrate) | |
| family | Classification of the different parameters following users defined norma- | Text; 255; NO |
| | tive/criteria for its subsequent classification according to the threshold approach | |
| | established by a given guideline/normative | |
| limMinNorm | Threshold value 1 for a given paramater for a given normative | Double; YES |
| limMedNorm | Threshold value2 (> than limMinNorm) for a given paramater for a given norma- | Double; YES |
| | tive | |
| limMaxNorm | Threshold value 3 (> que LimMedNorm) for a given paramater for a given | Double; NO |
| | normative | |
| paramClassification1/ | Classification parameter 1-2 by the normative | Text; 50; NO |
| paramClassification2 | | |
| otherhydrocheNormativeDetails | Additional data | Text; 255; NO |
| observations | Observations of the person that introduce the data into the database | Text; 255; NO |

4.5.5 HydrochemicalLaboratoryParameters

This table acts as a library, if the parameters nomenclature and its properties for a given laboratory/entity is already included, you do not need to add a new term.

| NAME OF THE FIELD | DESCRIPTION | FORMAT |
|-------------------------------------|--|---------------|
| hydrochemicalParametersCode ** | Unique Identify for each parameter from ListHydroChemicalParameters; | INTEGER; |
| | field:parameterId | YES |
| laboratoryId** | Laboratory entity in charge of collecting data in lab or the entity that provide the | INTEGER; |
| | information | YES |
| laboratoryParameter | Parameter used by the entity in charge of providing/analysing hydrochemical data | Text; 30; NO |
| uomCode | Units of measurements of the laboratoryParameter | INTEGER; |
| | | YES |
| detectionLimit | Parameter detection limit | Double; NO |
| processId** | Procedure of the analysis | INTEGER; |
| | | YES |
| paramClassification1/ | Classification parameter1-2 by the entity | Text; 50; NO |
| paramClassification2 | | |
| citationId** | Citation of the document that contain the details of the analysis methodology, | INTEGER; |
| | nomenclature, etc of the parameter (e.g. protocol established by the laboratory). | YES |
| | Dropdown list from DB_References | |
| otherHydrochemicalLaboratoryDetails | Additional data | Text; 255; NO |
| observations | Observations of the person that introduce the data into the database | Text; 255; NO |

References

This data model was generated taken into account different International Standards and on-going projects. These include data specification of the following:

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(new abstract inserted; minor changes in the text and figures)

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