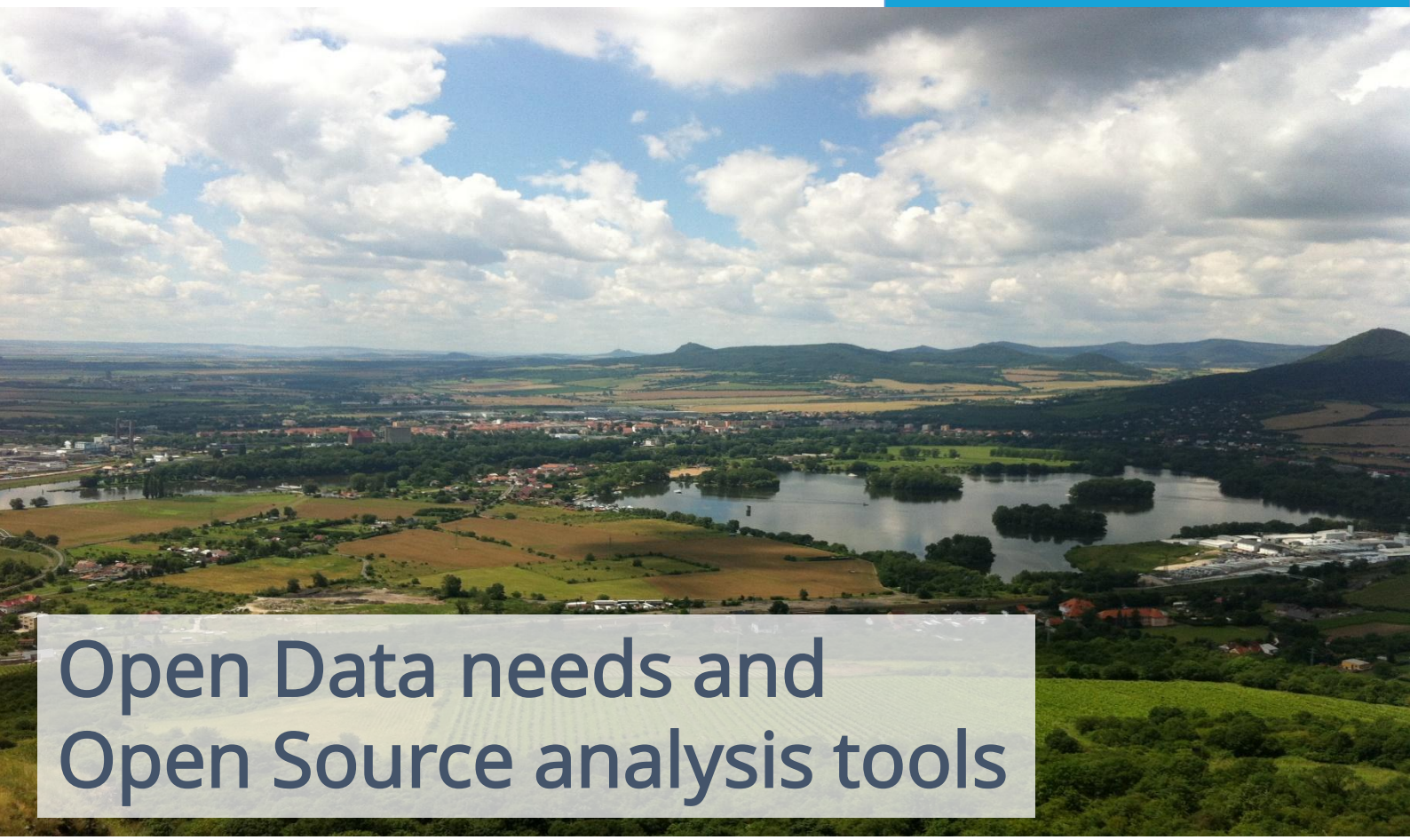
FREEWAT

Free and Open Source Software Tools for Water Resource Management

EU HORIZON 2020 Project

Policy Brief N. 3/7



Open Data needs and Open Source analysis tools

Key Policy Messages

- ✓ Open Data is the key factor toward Open Science using FREEWAT
- ✓ AkvaGIS facilitate the preprocessing of hydrogeological analysis and interpretation
- ✓ Observations analysis and management tools integrated in the model environment simplify the model development

WHAT H2020 FREEWAT is

FREEWAT is an HORIZON 2020 project financed by the EU Commission, aiming at promoting water resource management through innovative ICT tools and participatory approach.

Main result of the project is the free and open-source FREEWAT software: a QGIS integrated environment, where several simulation codes, based on the hydrological cycle, hydrochemical or economic-social processes, are integrated in a unique GIS project for conjunctive use of surface- & ground-water.

This Policy Brief is part of series of seven whose goal is to illustrate the FREEWAT approach and achievements.

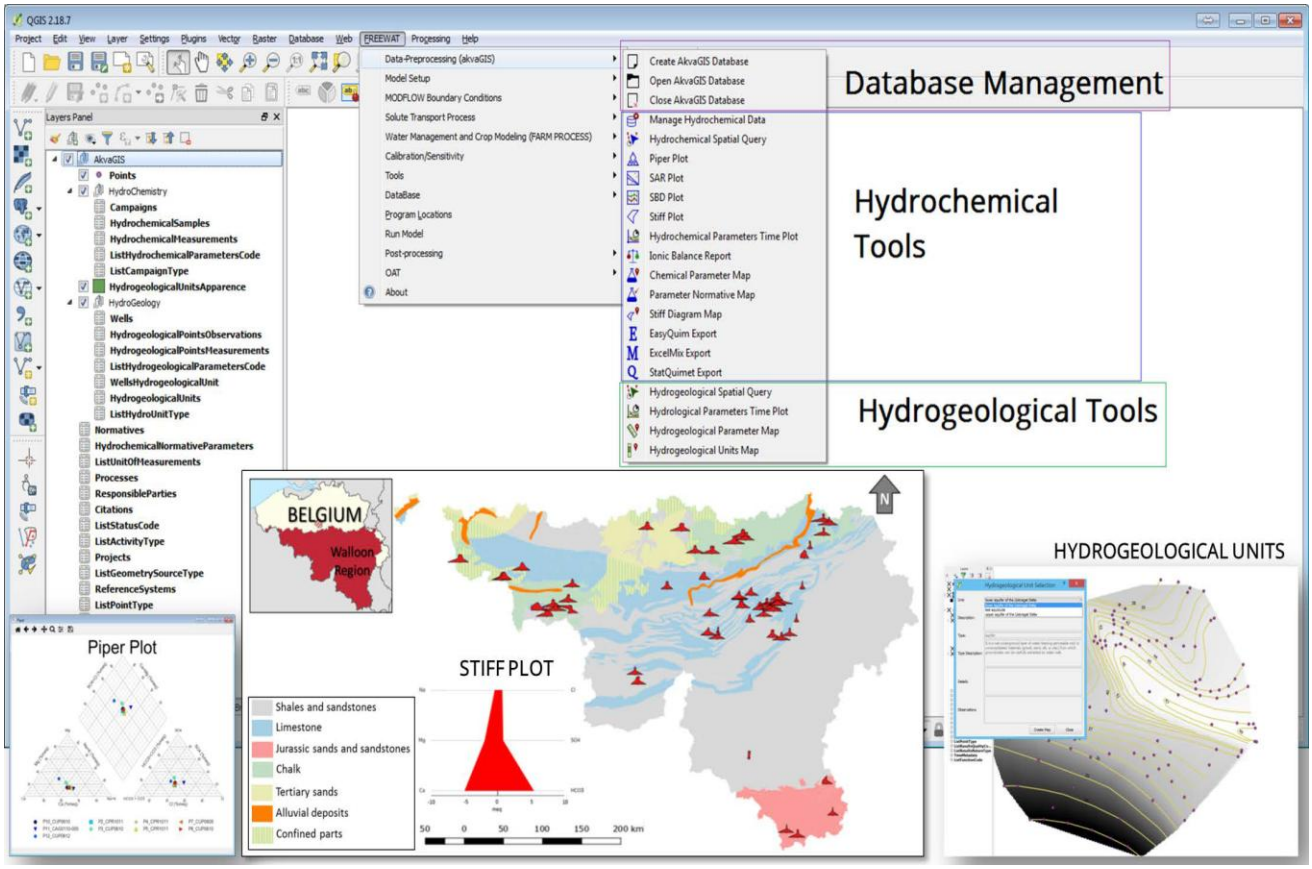
The FREEWAT project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement n. 642224.

AkvaGIS facilitate the preprocessing of hydrogeological analysis and interpretation

AkvaGIS was created to facilitate the pre-processing of further hydrogeological analysis and interpretations and it complements the functionalities of the FREEWAT platform in the QGIS environment (http://qgis.org). This tool include different instruments: (i) to manipulate large data collected along a time period; (ii) to integrate data from diverse sources that is 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.

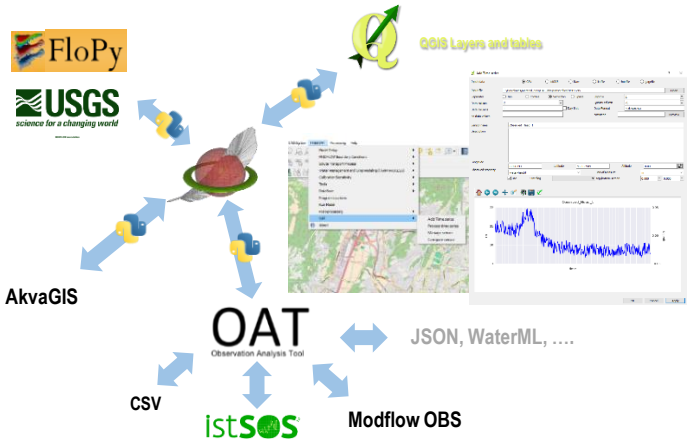
The AKVAGIS tools have been further improved with feedback experience of the FREEWAT courses and applications to some case studies to ease the user performance.

For instance, AkvaGIS has been applied in the Walloon Region (Belgium) in the framework of a project which aimed to investigate the occurrence and the indirect emissions of greenhouse gases (GHGs) from groundwater at a regional scale. Scientific community, public administration and also the private sector (e.g. water management, water supply, mining control, etc.) can benefit of this platform and tools.



AkvaGIS tools may be divided in three groups: Database management (grouped in lilac line), hydrochemical tools (grouped in blue line) and hydrogeological tools (grouped in green line). The STIFF maps of the Walloon Region (Belgium) is showed in the lower-center of the figure. Other useful tools can be applied such as the Piper diagrams (showed in the lower-left corner) or can be used to create input files for numerical model (e.g. hydrogeological units, showed in the lower-right corner).

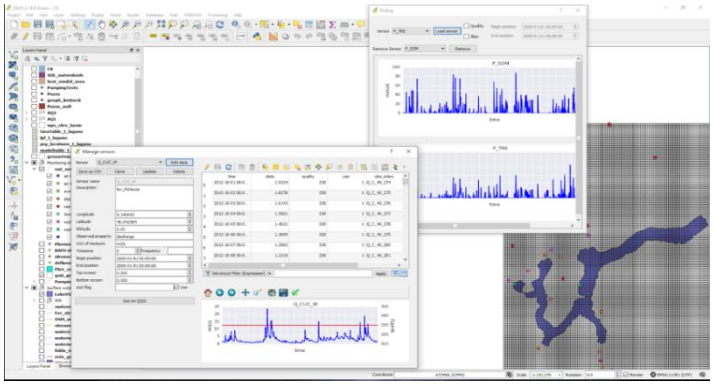
Observations analysis and management tools integrated in the model environment simplify the model development



Data collection and selection process is often considered one of the most difficult task in water management. When limited data are available for a region, the resulting model could have limited output compared to the potentially achievable results. Despite the INSPIRE directive has paved the way toward a well-defined and homogeneous geospatial data infrastructure only few FREEWAT case studies were able to collect data from online searchable data catalogue portal with appropriate metadata information.

Furthermore, a very import type of data required for model set-up, calibration and validation are observations. These data-sets are generally available as time series values from monitoring networks and/or campaigns and includes: climates (rainfall, temperature); hydrological conditions (water bodies stages, discharge values); hydrogeological parameters (conductivities, piezometric heads); water management practices (irrigation and pumping rates); and quality parameters (salinity, chemicals concentrations).

OAT (Cannata et al., 2016) is a Python package which is integrated in the FREEWAT environment through a user interface. OAT library implements objects and features to import data from different sources (including online servers or MODFLOW files), archive data and metadata locally in an SpatiaLite repository, run specific processing algorithms to prepare or complete the datasets according to model needs, and export time-series in several output formats (for example UCODE observation files).



The implemented library approach greatly facilitates the expansion of the available algorithms for time series analysis by just adding new processing code as new OAT objects.

In the FREEWAT Lugano lake case study (Cannata et al., 2017) OAT was used to prepare and calibrate the model. Temperature, precipitation, stream discharge, stream height, humidity, atmospheric pressure, and lake level at daily resolution have been directly imported in the model platform from a Web Sensor Observation Service compliant server. Thanks to OAT, various filters and resampling or data fill methods new, but statistically sounding, time-series at the model set temporal discretisation of 7-day stress periods, were produced. Temperature data was processed with a OAT process to calculate evaporation through the Hargreaves-Samani equation and it was used for the evaluation of direct evaporation from the lake. Precipitation was used to calculate the recharge applied to the model cells using the MODFLOW recharge package, mountain front recharge using the MODFLOW well package, as well as direct precipitation to the lake surface. OAT was also used to automatic convert time series data from groundwater observation wells to MODFLOW head observations layers. Thanks to the OAT difference method was easy to calculate flow observation from two streamflow gages to represent the water gain or lost by a river segment to conduct calibration using UCODE.

Finally, FREEWAT generated head and flow observations, listing file volumetric budget components (either as cumulative budgets or rates), and gage file components can be imported in OAT to visually display or analyse model results.

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Open Data is the key factor toward Open Science using FREEWAT

The European Commission in "Open Innovation, Open Science, Open to the World – a vision for Europe" stated: «*Open Science represents a new approach to the scientific process, based on cooperative work and new ways of diffusing knowledge by using digital technologies and new collaborative tools.*. ».

Open Science is strongly supported, in fact it increases:

- Efficiency: access to input and output data help improving productivity of the research.
- Quality and integrity: OS permits a greater and more accurate replication and validation of research results.
- Economic benefits: access to scientific results boosts innovation, also in developing economies.
- Innovation and knowledge transfer: OS reduce delays in transferring knowledge and create new products
- Public disclosure and engagement: open to society for citizen's participation
- Global benefits: international sharing of challenges understanding.

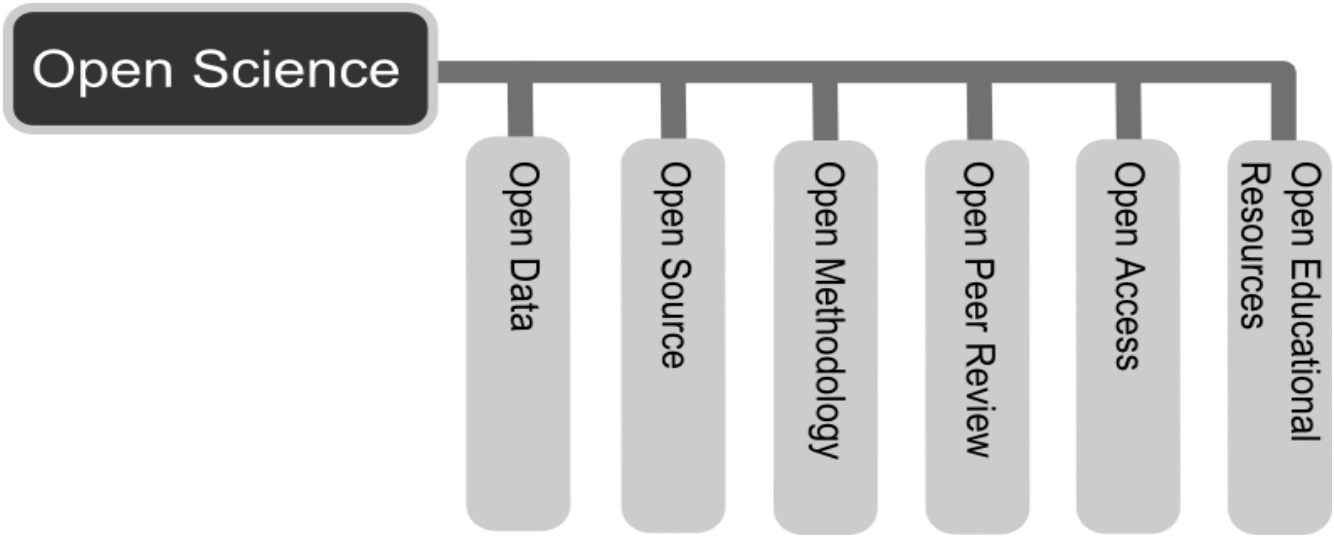
Open Science is based on several pillars, fully addressed by the FREEWAT project. In fact, FREEWAT is fully Open Source (GPL license), educational resources like tutorials and user documentation are available with Open Access licenses, case study data are available with Open Data license.

Data used for the implementation of each case study, together with elaboration and model required information have been packaged and uploaded on a Web repository for online access and download.

During the H2020 FREEWAT project, openness and accessibility of data has been identified as an element of primary importance. Having open data and open source tools allows sharing the analysis while this is conceived.

Data is essential and fundamental in water management analysis. Without data models may not be built. FREEWAT has also showed that sometimes authoritative data are not yet available with Open Data license and this prevents analysis or limit its impact.

In FREEWAT AKVAGIS and OAT are tools for managing water-related data and for preparing them for simulation analysis.



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