



# **FREEWAT**

Free and Open Source Software Tools for Water Resource Management  
EU HORIZON 2020 Project

## **FREEWAT**

**FREE and open source software tools for  
WATER resource management**

### **FREEWAT platform v.1.0 and User Manual v.1.0**

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## Abstract

This report describes the features of FREEWAT platform v.1.0, namely the first official release of the software, largely tested during local courses (Work Package, WP, 3) and case studies modeling activity (WP4 and WP5).

The public release of FREEWAT was expected for July 2017, at Month 28. However, in accordance with the EASME, due to the increasing interest in the FREEWAT project and software, such a task was anticipated in April 2017 (Month 25). On the other hand, this change in the project timeline gave the possibility to collect several suggestions from the User's community around the world. For this reason, while in July 2017 the FREEWAT v.0.5 was released, this final official release (v.1.0) has been postponed to the end of the project (Month 30), aiming at including as many as possible enhancements and improvements of FREEWAT capabilities.

FREEWAT code v.1.0 is part of a more extended ecosystem, made by: documentation material (user's manuals, tutorials released in Deliverable 3.2), code repository, repository for documentation, two public forums (one for users and one for developers). A Reference Manual (Volume 0) made up of the content of Deliverables 2.2, 2.3, 2.4, 2.5, 2.6, 2.7 and 2.10 has been added. The focal point of this ecosystem is the website of FREEWAT project, download section.

This report is endowed with two annexes, namely the compressed archive of source code and the updated version of the User and Reference Manuals, respectively.

## 1 Introduction

In July 2016 (Month 16), FREEWAT platform was released as version 0.1, namely as the first stable version after the preliminary Beta v.0.1, dated January 31<sup>st</sup> 2016. It incorporated several enhancement and bug fixing suggested by participants of the “training the trainers” activity (Work Package, WP, 3).

Since that time, a 2-month schedule for periodic release was decided by Developers team. In this period, thanks to the huge effort made during dissemination and exploitation activity (WP 8), the FREEWAT platform acquired a huge interest from people external to the project (non-partner public institutions, companies and professionals). This success suggested, in accordance with the EC, to go towards an anticipated public release (formerly expected for Month 28 of the project timeline), which concretized in April 2017 (release v.0.4). In that occasion, a dedicated page of the project website was released to host the public download service to get: Source Code, User’s Manuals and Tutorials. This process implied a huge and additional effort spent by Developers partners (WP 2), as well as in coordination (WP 1) and dissemination (WP 8) activities.

On the other hand, the increasing number of FREEWAT Users (especially non-partner Users) fed several suggestions to enhance and strength the modeling platform, from the User’s perspective (see Deliverable 8.9 for details).

As a consequence of this new timeline, the Steering Group decided to release the final version (v.1.0) at the end of the project (Month 30), and to announce that during the project Final Meeting (held in Barcelona, September 20-22, 2017).

The final version (v.1.0) is attached to this report. Compared to the previous version (v.0.5) no structural further development has been carried out, while an extensive code cleaning and optimization has been performed, along with the fixing of remaining bugs.

This report summarizes the release history up to the current version (Section 2) and describes the final FREEWAT ecosystem, which is now available (Section 3). Finally, a summary of the Annexes to this document is reported in Section 4.

## 2 Release history (since v.0.1)

This section reports the release history since v.0.1 (described in Deliverable 2.8), to trace the enhancement and development of the software up to the current release v.1.0.

### *Release v.1.0*

- Master
  - Improvement of Copy to Vector: now the Copy function works only on selected features in input layer (if any)
  - Run Model speed-up: info on several MDOs is now gathered directly from DB, which reduces a lot the time for creating input files
  - Several Progress Bars included during Run Model process (giving info to User about the model data pre-processing)
  - Improvement of WEL Package: it is possible also to automatically select WELL cells in your grid, using a linear shape file in input
  - Improvement of CHD Package: it is possible to create CHE MDO starting from a linear shape file, and getting the Head (in each cell) as interpolated values, giving as input In and Out head values (as for RIV, GHB, etc.)
  - Improvement of GHB Package: it is possible to input In and Out head values, to get the head values (in each cell) as interpolated values
  - Installation procedure has been modified, to be compliant with QGIS Plugin Repository
  - Automated testing procedures included for several tools, for Developers' convenience
- Water management and crop modelling
  - Crop Growth Module is now a separate tool, independent upon Run Model GUI, accessible directly from FREEWAT > Water Management sub-menu

### *Release v.0.5*

- Master
  - Add USE and GROUP field to MDO for WEL Package.
  - Speed up of Copy to Vector between Spatialite layers (e.g. between model layers).
  - Possibility to apply Copy to Vector tool only on selected features of source layer.
  - Pop-up messages for missing exe files in ProgramLocations table.
  - Fix bug in SFR2 object builder, when flopy >= 3.2.6
  - MODPATH (Particle Tracking) Fixing, Update and Improvement: now you can create several MODPATH simulations and starting particles from a selected area where RCH or WEL are applied (backward and forward).
  - Update on ZoneBudget output: now a CSV file with budget for each zone is saved in your working directory.

- Speed up of Run Model (1st stage: to retrieve grid size).
- Bug fixing in SSM WEL: only with selected SPs it did not work.
- Small bug fixing in running UZF with flopy  $\geq$  3.2.6
- Calibration
  - Solving small bugs in calibration: (i) when no multi-layer observation is present; (ii) reducing number of figures in floating point format when negative numbers are present: this prevents bad writing of HOB input file.

#### *Release v.0.4.1*

- Master
  - Now FREEWAT is compliant with latest flopy version 3.2.6
- Calibration
  - Calibration plots are now working under Linux, Win XP, 7, 10

#### *Release v.0.4*

- Master
  - Update of csv\_templates folder.
  - Post-processing) Including a tool for cross section visualization of model result (flow and transport).
  - Installation) Fix and improve several parts in pip and numpy installation (Windows and Linux ), including the one fro proxy port.
  - Run Model) Enhancement on window showing the final message after simulations (MOFLOW, MODFLOW-OWHM, MT3D, SEAWAT).
  - Post-processing) Saving Vol. Budget as CSV: now the CSV contains Volumes and Flow rates for all the Stress Periods.
  - Enhanced error handling on LAK interface.
  - Fix import LAK package.
  - Modified import from csv to define lake stress periods (LAK).
  - Add possibility to upload stress period data from csv (LAK).
  - Add Italian translation for Create LAK ui.
- AkvaGIS
  - Fix time plot icons in akvaGIS.
- Transport
  - Including Package UZT (Unsaturated Zone Transport) of new code MT3D-USGS.
  - Fix bugs in Transport, in case of multi-component models.
- OAT
  - Fix problem when loading data from hob file (missing measures).
  - Add italian translation to OAT interface.
  - Add possibility to select all available sensors when loading from istSOS.
  - Add possibility to upload multiple sensors from IstSOS.

*Release v.0.3*

- Master
  - Improvement of the installation procedure needed if some Python libraries are missing.
  - Improvements on RIV, GHB and DRN package:
    - Possibility to create a unique MDO for multi-line river (or drain or ghb boundary) directly from a multi-line GIS layer.
    - Speed up of MDOs creation.
  - Help files included in (almost) GUIs for MODFLOW Boundary conditions.
- Calibration
  - Possibility to apply zones option to LPF and RCH/EVT parameters table.
  - Model fit plot and main statistics included under Post-processing menu.

*Release v.0.2*

- Master
  - New method to create MDO (Model Data Object) for Model Layer (corresponding to the MODFLOW layer for rendering the vertical discretization), and package usually defined on the whole grid (RCH, EVT, UZF, FARM IDs, SSM for RCH and EVT).
  - MODPATH is now included, under Post-processing menu. It applies the particle tracking method to results coming from a MODFLOW simulation. At this stage, this tool is tested only with the link to WEL package, in backward mode, for defining the capture zones related to any well present in the model.

### 3 FREEWAT Software Ecosystem

At the end of the project (Month 30, September 30<sup>th</sup> 2017) FREEWAT is released as a software ecosystem consisting of:

- QGIS FREEWAT plugin, available in the official FREEWAT QGIS repository.
- FREEWAT source code repository: open to public, under the GitLab GIT open source manager system (to organize the whole code development, including issues tracking, release management, etc.). In the Wiki Section of this repository a specific page *How to contribute to the code*, has been included, to guide developers external to the project consortium on contributing to the code. This page is available. The GitLab repository is available at the following web address: <https://gitlab.com/freewat/freewat/>
- FREEWAT manual repository: restricted to project partners involved in WP2, and managed under the GitLab GIT open source manager system as well.
- FREEWAT Installation Guide: a quick guide to get an effective installation of FREEWAT plugin.
- FREEWAT User's Manuals: six volumes describing how to apply the FREEWAT capabilities, each one dedicated to a specific part of the platform.
  - FREEWAT Reference Manual: a document describing the theoretical and technical concepts behind the FREEWAT code, as well as some illustrative examples of applications. This document is made up of the content of Deliverables 2.2, 2.3, 2.4, 2.5, 2.6, 2.7 and 2.10.
- FREEWAT Tutorials (available for free download in FREEWAT web site): 11 tutorials covering the main capabilities of the modeling platform.
- FREEWAT Users Community, based upon an open web forum for managing Questions&Answer pipeline (already active at: <https://groups.google.com/forum/#!forum/freewat-users-group> ).
- FREEWAT Developers Community, based upon an open web forum to exchange ideas and experience among existing and potential developers (already available at: <https://groups.google.com/forum/#!forum/freewat-developers-group> ).

Finally, under the guidance of partner OSLANDIA, FREEWAT will be prepared for incubation (as open source project) under *OSGeo Community* (*Open Source Geospatial* foundation), a not-for-profit organization whose mission is to foster global adoption of open geospatial technology (<http://www.osgeo.org>).



## 4 Deviation from Work Plan

As stated in the Introduction section, the public release of FREEWAT was formerly expected for July 2017, Month 28. However, in accordance with the EC, due to the increasing interest on the FREEWAT project and software, such a task was anticipated in April 2017 (Month 25). On the other hand, this change in the project timeline allowed collecting several suggestions from the User's community around the world. For this reason, the final official release (v.1.0) has been postponed to the end of the project (Month 30), aiming at including as many as possible enhancements and improvements of FREEWAT capabilities.

## 5 Conclusions

Version 1.0 of the modeling platform has been released as final result of the huge efforts spent in WP2 by all the involved partners, as well as thanks to contributions coming from all the other partners and extra-Consortium stakeholders interested in FREEWAT development and application.

In order to coordinate a number of Deliverable's documents, a Reference Manual (Volume 0) made up of the content of Deliverables 2.2, 2.3, 2.4, 2.5, 2.6, 2.7 and 2.10 has been added. This sums up the above-mentioned deliverables.

This change with respect to the original project timeline reflects the positive deviation from what expected in the proposal: the huge success and impact of the software suggested to make it available beyond the project consortium as soon as possible, while Developers decided to take all the available project time to enhance as much as possible the software capabilities and performance.

## Document History

31.07.2017 Release of v1.0

30.09.2017 Release of v2.0

30.09.2017 Release of v2.1 after Coordinator's review

## Appendix A Source code

The zip archive Annex\_1\_FREEWAT\_v.1.0.zip contains the *freewat* folder with FREEWAT Python code included.

This content reflects the code version frozen on September 30th, 2017 and tagged as Version 1.0 within the GitLab repository.

Furthermore, according to the project data sharing procedure, this material has been uploaded within the cloud platform *B2Drop*, to allow file sharing and downloading among partners.

## Appendix B User and Reference Manual

The zip archive Annex\_2\_FREEWAT\_manual\_v.1.0.zip contains the updated version of the FREEWAT User Manuals. In particular, it archives the following pdf files:

- *FREEWAT\_vol0.pdf* (FREEWAT User Manual – Volume 0, *Reference Manual*);
- *FREEWAT\_vol1.pdf* (FREEWAT User Manual – Volume 1, *Groundwater modeling using MODFLOW-OWHM (One Water Hydrologic Flow Model)*);
- *FREEWAT\_vol2.pdf* (FREEWAT User Manual – Volume 2, *Heat and Solute Transport in Subsurface Water Flow*);
- *FREEWAT\_vol3.pdf* (FREEWAT User Manual – Volume 3, *Water management and crop-growth modeling*);
- *FREEWAT\_vol4.pdf* (FREEWAT User Manual – Volume 4, *AkvaGIS (Hydrochemical Analysis Tools and Hydrogeological Analysis Tools)*);
- *FREEWAT\_vol5.pdf* (FREEWAT User Manual – Volume 5, *Observation Analysis Tool*);
- *FREEWAT\_vol6.pdf* (FREEWAT User Manual – Volume 6, *MODFLOW OBServation process*).

As for the code, a copy of this documentation is also stored within *B2Drop* cloud platform.