The growing demand of freshwater for meeting human needs (e.g., food and energy production, irrigation, drinking water) results in compelling requirements for advanced tools, based on data, in order to promote sustainable management of water resources. According to the EU regulations on water (e.g., the Water Framework Directive), ICTs may provide answers to the most urgent problems affecting the water sector, especially when focusing on groundwater resource planning and management scarcity prone conditions.

In this framework, the HORIZON 2020 FREEWAT (FREE and open source software tools for WATer resource management; www.freewat.eu) project aimed at promoting the development and the application of innovative software tools for supporting water resource management, focusing then on groundwater (Rossetto et al., 2015). FREEWAT's main outcome consists in a free and open source platform, QGIS-integrated, for the simulation of the hydrologic cycle (De Filippis et al., 2017). The FREEWAT platform takes advantage of coupling the power of GIS geo-processing and post-processing tools in spatial data analysis with that of process-based simulation models. This results in a unique modelling environment where large spatial datasets can be stored, managed and visualized and where several simulation codes (mainly belonging to the USGS MODFLOW family) are integrated to simulate multiple hydrological, hydrochemical or economic-social processes.

The FREEWAT platform includes 6 modules for data pre-processing and model implementation:

- the AkvaGIS module provides several tools for the analysis and interpretation of hydrochemical and hydrogeological data;
- the Observation Analysis Tool (OAT; Cannata and Neumann, 2017) is a pre-processing tool to provide the User with enhanced time-series processing capabilities, in view of an increasing establishment of diffuse, online and real-time monitoring networks and of supporting model construction and advanced model calibration;
- groundwater flow dynamics in the saturated and unsaturated zones may be performed using MODFLOW-2005 (Harbaugh, 2005);
- in FREEWAT, the hydrological model can be coupled with a solute transport model, to simulate (i) multi-species advective-dispersive transport, in the saturated zone, using MT3DMS (Zheng and Wang, 1999), (ii) 1D solute transport within the unsaturated zone with MT3D-USGS (Bedekar et al., 2016), and (iii) viscosity- and density-dependent flows using SEAWAT (Langevin et al., 2007);
- water resource management is accomplished by integrating MODFLOW-OWHM (One-Water Hydrologic Flow Model; Hanson et al., 2014);
- the UCODE_2014 (Poeter et al., 2014) is implemented to perform sensitivity analysis and parameter estimation.

Within the H2020 FREEWAT project, FREEWAT capabilities have been tested and applied to 14 case studies, in EU and non-EU countries, for targeting issues related to rural water management and to the application of EU regulations (e.g., the Water Framework Directive, the Nitrate Directive, the Flood Directive, etc.). The FREEWAT platform is also being applied within further EU

projects, such as the LIFE REWAT (sustainable WATer management in the lower Cornia valley through demand REduction, aquifer REcharge and river REstoration; www.liferewat.eu) project.

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