Geophysical Research Abstracts
Vol. 21, EGU2019-13050, 2019
EGU General Assembly 2019

A modelling approach for dealing with conjunctive use of ground- and surface-water and crop yield in rural water management

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Groundwater resources are facing growing pressure worldwide, due to overexploitation and climate change. This especially occurs in rural areas, where the bulk of water consumption occurs. Conjunctive use of ground- and surface-water is increasingly being a common practice worldwide aiming at crop production stabilization and sustainability. Smart ICT (Information and Communication Technology) solutions, such as GIS-integrated simulation models, may help water managers to estimate the effects of natural and human impacts on groundwater resource and to properly manage water-constrained agricultural production.
In the framework of the HORIZON 2020 FREEWAT project, this topic has been especially taken into account, as rural water resource management was considered a major priority by relevant stakeholders. The main result of the FREEWAT project consists in an open source and public domain, QGIS-integrated modeling platform for promoting water resource management.
Among the capabilities of the FREEWAT platform, attention has been payed to the integration of modelling tools for conjunctive use of ground- and surface-water in rural areas. This is accomplished by the Farm Process (FMP), a module embedded in MODFLOW-OWHM (MODFLOW One-Water Hydrologic Flow Model). FMP integrates the hydrological budget calculated by MODFLOW-2005 with supply-and-demand components of irrigated agriculture on a farm scale. Within the FREEWAT platform, FMP was coupled to a module for crop growth modeling, in order to simulate crop yield based on water availability and crop water demand as estimated by FMP. To achieve this purpose, the radiation-based Crop Growth Module (CGM), based on the EPIC family models, was integrated to predict crop yield at farm and basin scale, under different climatic and water supply constraints. In this approach, CGM exploits FMP results related to water uptake and estimates crop yield at harvest based on water availability in the unsaturated zone. All the processes involved are affected by weather and crop-specific variables. The coupling approach has been tested by setting up a simple synthetic application, where the yield of irrigated sunflower at harvest in a Mediterranean area is simulated.
The proposed solution intends to provide water authorities and public/private companies with a dynamic tool for data-based agricultural water management. In this view, the proposed approach aims at supporting the setting in operation of irrigation schemes devoted to managing conjunctive use, thus reducing unplanned and unmanaged use of private irrigation wells. Despite the open source and free characteristics of the software may favor widespread use, capacity building activities are needed to boost digitalization in the agricultural water sector for improving water management.
Acknowledgements
This paper provides exploitation of the H2020 FREEWAT project (FREE and open source software tools for WATer resource management; www.freewat.eu) results. The FREEWAT project received funding from the European Union's HORIZON 2020 research and innovation programme under Grant Agreement n. 642224.