



Development of a new modeling framework for estimating water needs in lowland agricultural areas: linking GIS database and SWAP simulation

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The implementation of adaptation strategies is becoming increasingly important to mitigate climate-related risks and water resource overuse in agriculture. When considering large spatial domains, the assessment of alternative irrigation techniques can be carried out using a modelling approach, useful to take into consideration all the relevant processes in complex agro-ecosystems.

In ‘fully distributed’ models, the domain of interest is divided into simulation units, each characterized by a unique set of parameters and inputs, by using a regular grid. In ‘semi-distributed’ models, simulation units correspond with spatial units of different size and shape but homogeneous in terms of parameters and inputs. Moreover, if the description of processes is based on simplified schematization of the physical system and equations, models are referred as ‘conceptual’, whereas if an accurate physical-mathematical description is adopted, they are considered as ‘physically based’. Because of their complexity and computational requirements, ‘physically based’ models are often applied in a ‘semi-distributed’ manner when describing large territories.

A framework is currently under development to directly link a file-based vector database (GeoPackage), describing the main features of an agricultural area, and ‘physically based’ simulations carried out by the SWAP model (<https://www.swap.alterra.nl/>). The framework, written in Python, runs within the QGIS environment. It requires the user to define seven basic themes: I) a district domain, II) soil types, III) land uses, IV) irrigation water distribution areas, V) homogeneous groundwater depth polygons or groundwater level measuring stations, VI) homogeneous agro-meteorological polygons or agro-meteorological stations, and VII) a DTM raster layer. From the intersection of the layers considered, a number of polygons are generated. Next, the polygons are post-processed based on one of the following options: a) aggregate all polygons characterized by the same value of the input themes, b) maintain all the polygons obtained through the intersection operation, or c) aggregate polygons based on a critical distance (meters). This last option is useful to limit the number of polygons and reduce the computational effort. In the case of multiple groundwater level or agro-meteorological measuring stations, the framework calculates the values of the variables to be assigned to each polygon through the ‘Inverse Distance Weighting’ (IDW) algorithm. Finally, the framework links each unit to its parameter set, transferring

the information stored in the database into the SWAP input files. Simulation results are saved in a tabular format that allows them to be analyzed according to different aggregations (by land use, soil type, etc.) and to produce time series graphs or vector maps.

The application of the tool for the estimation of the irrigation requirements and the percolation fluxes of the Lomellina region (northern Italy) under the current and alternative irrigation strategies will be presented and discussed. The study area, located on the left bank of the Po River, covers more than 125,000 hectares mainly cropped with rice. In more recent years, this area is experiencing water shortages and a reduction in aquifer levels.