Enhanced flexibility and coupling opportunities: the process-based, open-source, hydrological-model WetSpa

Authors: E. Salvadore¹, J. Bronders², O. Schmitz³, O. Batelaan¹

¹ Dept. of Hydrology and Hydraulic Engineering, Vrije Universiteit Brussel, Pleinlaan 2, 1050 Brussles, Belgium.
² VITO, Flemish Institute for Technological Research, Boeretang 200, B-2400 Mol, Belgium.
³ Dept. of Physical Geography, Faculty of Geosciences, Utrecht University, Heidelberglaan 2, PO Box 80115, 3508 TC Utrecht, The Netherlands
⁴ School of the Environment, Flinders University, GPO Box 2100, SA 5001, Adelaide, Australia.

Abstract:

Hydrological modeling is evolving following advances in computational capabilities and the spread of digital data. Keeping up with technological development is becoming a challenge and might result in increased complexity and higher uncertainties. Many tools are today available to simulate particular hydrological processes but the water system at the catchment scale requires the integration of several domains. For all these reasons flexibility and ease of integration are important requirements for the hydrological models of tomorrow. To this end, we considered the spatially distributed hydrological model WetSpa (Water and energy transfer between Soil plant and atmosphere) and we modified its structure and language. The goal of this research was to provide a reliable open source tool for hydrological studies which is at the same time flexible, easy to use and to couple with new or existing external models.

The new structure of the model is modular and written in Python language. Every physically-based process (such as interception, runoff, infiltration, etc.) is coded in a separate module and the modules exchange data during running time through a modeling framework prototype. The user can select which processes will be simulated and the spatial and temporal resolution of each process separately, while the framework takes care of the order of calculation and of data exchange (i.e. no need for pre- and post-processing). The new structure allows the user to modify the model complexity according to data availability and case specific requirements in a straightforward way. Moreover different formulations of the same hydrological process can be easily tested as the modules have a standard and interchangeable format. Furthermore, the model was successfully coupled with other (non-)open source software such as the groundwater flow model MODFLOW and a dynamic land use change model. The new WetSpa model is therefore much more suited for future development and to support researchers in their future hydrological questions.