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Modelling surface hydrology with DR2-SAGA 1.0: development of a user-friendly interface for hillslope water balance assessments

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Soil moisture variability and the depth of water stored in the arable layer of the soil are important topics in agricultural research and rangeland management. Additionally, runoff triggers soil detachment and sediment delivery, and thus is one of the most important factors in the soil erosion dynamic. Overland flow generation and accumulation are non-linear and scale-dependent processes and the development of prediction models helps researchers evaluate different scenarios at different temporal and spatial scales. In this study, we present the DR2-SAGA 1.0 module to the scientific community. The DR2 (Distributed Rainfall-Runoff) water balance model computes the depth of water stored within the soil profile (Waa) distinguishing five scenarios of the upslope contributing area, infiltration processes and climatic parameters, and assesses the soil moisture status (SMS) throughout the year for an average monthly rainfall event. The SAGA program is a free Geographical Information System (GIS) with support for vector and, specially, raster data. Its foundation is its Application Programming Interface (API), which provides data object models and basic definitions for the programming of scientific modules. Module libraries contain the scientific methods and are developed using C++ code. The new module was run in a medium size mountain Mediterranean catchment (246 ha; Spanish Central Pre-Pyrenees) at high spatial resolution (5 x 5 meters of cell size). The Estaña Lakes Catchment is affected by karstic processes which explain the presence of 15 endorheic sub-catchments and three fresh-water lakes. Additionally, this area is ungauged and offers the opportunity to test the performance of the new module in a non-conventional landscape. DR2-SAGA 1.0 demands 16 inputs and generates monthly and annual maps of initial and effective runoff depth, Waa and SMS. One user-friendly tab was created with SAGA 2.0.8 for each input and output file. The new module also includes a water balance routine to obtain accurate maps of effective cumulative runoff for any type of accumulation algorithm used. In order to make more readable the results and their legends, a predefined layout was created for each derived map. Further research seeks the development of an equation to add the Effective Hydrological Depth factor in order to improve the reliability of the model in shallow soils. A basic statistical analysis package will also appear in the next version of the module. The development of the DR2-SAGA 1.0 module in the open-source SAGA platform boosts the simulation capacity of the DR2 model in comparison with its application in other commercial GIS software. As a result, we present a scientific module that brings together the set of equations, mathematical calculations and GIS operations included in the DR2 model. DR2-SAGA 1.0 provides a powerful and efficient tool with an intuitive graphical user interface having a low computational cost. In general, DR2-SAGA 1.0 shows great potential for hydrological studies in small and medium size catchments and can be used by both advanced and non-expert users. The new module will be available in the web site of our research center in spring 2013.