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A multi-criteria parameterisation strategy for the hydrological modelling of storm events in an agricultural catchment

D.W. Hallema (1) and R. Moussa (2)

(1) INRA, Laboratoire d'etude des Interactions entre Sol - Agrosysteme - Hydrosysteme (LISAH), UMR SupAgro - INRA - IRD, 2 Place Pierre Viala, 34060 Montpellier Cedex 1, France (hallema@supagro.inra.fr), (2) INRA, Laboratoire d'etude des Interactions entre Sol - Agrosysteme - Hydrosysteme (LISAH), UMR SupAgro - INRA - IRD, 2 Place Pierre Viala, 34060 Montpellier Cedex 1, France (moussa@supagro.inra.fr)

The parameterisation of physically based hydrological models is a key factor in evaluating their performance and improving their adequacy. In comparison to natural catchments, the parameterisation of agricultural catchment models requires a special approach since agricultural practice, such as tillage, introduces a temporal variability in the hydraulic conductivity of the soil. This study aims to develop and evaluate a parameterisation strategy for the hydrological modelling of storm events in a Mediterranean agricultural catchment. The adopted methodology accounts for a spatio-temporally variable land use, combined with the presence of an artificial drainage network and the occurrence of short duration-high intensity storm events. A parameterisation of 43 events covering a 12-year period was carried out applying MHYDAS (Distributed HYdrological Modelling for AgroSystems) to the Roujan catchment (0.91 km^2) in southern France.

Parameterisation of MHYDAS is particularly difficult considering the large number of spatio-temporally variable parameters involved. To incorporate this variability, the catchment was divided into hydrological units that are considered hydrologically homogeneous, mostly parcels separated by field boundaries and ditches. The parameterisation was performed in four parts. Firstly, the appropriate flood routing equation was selected for each channel reach in the drainage network: kinematic wave where possible and diffuse wave for the other reaches. Secondly, the boundary conditions (geometry, connectivity and roughness of hydrological units and ditches) were assumed equal for all events, while soil hydrodynamic properties and initial soil moisture content were taken variable in time. A third step was to calibrate individual events by manually tuning the average overland- and channel flow celerity, saturated hydraulic conductivity, and two coefficients for the channel infiltration and exfiltration fluxes. The predictive power of each simulation was assessed using multi-objective functions related to volume, peak flow, and the Nash-Sutcliffe coefficient. The last step was a global calibration and validation on 33 events. The results of the calibration of individual events have demonstrated that events can be properly parameterised using the current strategy, assuming that channel exfiltration does not contribute to runoff. It was concluded that the average overland- and channel flow celerity, and the channel infiltration coefficient have remained relatively constant. This study has demonstrated that extensive data collection in combination with a multi-criteria parameterisation strategy is an important tool for calibrating and evaluating hydrological models for agricultural environments.