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EHSM: a new conceptual model for daily streamflow simulation under ecohydrological framework

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A parsimonious conceptual lumped model is presented here with the aim of simulating daily streamflow in semi-arid areas. The model is able to reproduce surface and sub-surface runoff, soil moisture dynamics and evapo-transpirative fluxes, averaged over a basin starting from daily time series of rainfall and temperature and from the initial value of soil.
The rainfall is partioned in two components: the first, which interests a totally impermeable area, is routed directly on a superficial linear reservoir, while the second passes through permeable soil. If the rainfall input exceeds the soil storage capacity, which is a function of soil moisture at that specific time, this saturation excess is routed on the superficial reservoir as well. When soil moisture is higher than the field capacity, the model simulates the leakage component, which is described as an instantaneous pulse from the soil bucket to a second deep linear reservoir. The two reservoirs work in parallel with different time of response: the superficial reservoir has a time lag of about 1-2 days, while the deep reservoir is characterized by a lag time of weeks.
Soil moisture dynamics, which are crucial in determining how much water could be keep or released as streamflow or leakage, are simulated with a simple bucket model feed by rainfall and depleted by evapotranspiration. The latter component is calculated as a stepwise function of soil moisture. When there is no limitation given by water availability in the soil, basin vegetation evapo-transpires at maximum level, which is a function of daily temperature and crop characteristics. When soil moisture decreases under a critical value (similar to a stomata closure point), evapotranspiration linearly decreases to zero.
The model has been calibrated using Montecarlo simulations on 23 Sicilian basins with very different hydrological behavior. This calibration method has allowed to adapt the conceptual model framework to the basin characteristics and at the same time to obtain the set of parameters with the higher efficiency in reproducing historical streamflow. Performances have been compared with the ones obtained with the IHACRES model, which is one of the most used models for daily streamflow simulation in semi-arid catchments. EHSM is able to obtain, on the analyzed basins, performances similar or better than IHACRES using a lower number of parameters. At the same time, the proposed model gives reliable estimate of soil moisture traces and evapotranspiration fluxes, variables very useful in support flood alert models or irrigation models.