A new ecohydrological distributed model for predicting vegetation dynamics effects on infiltration and runoff propagation: the Mulargia basin case study in Sardinia.

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One of the main characteristics of the basins in the Mediterranean area is the seasonality of its climate, with the main rain events during the winter and fall and low or totally absent rain events during the rest of the seasons. This rainfall variability drives the growth and the dynamics of grass vegetation, which consequently reaches its maximum development during the more humid periods and is lower or totally absent during the dry periods. Vegetation cover has an important role on infiltration and runoff processes because it influences the most important soil hydrological properties.

Montaldo et al. (2020) demonstrated that at the plot spatial scale the effect of grass growth on a key soil hydraulic parameter, the saturated hydraulic conductivity (ks), is crucial for modelling runoff at both event and larger (monthly) time scales. In contrast to the common hydrological models where the key hydrological parameters for the infiltration and runoff processes are time-invariant, we propose an accurate ecohydrological physically based distributed model that includes the dynamic of vegetation and its effects on soil hydrological properties, including the variability of *ks* and hydraulic roughness (*v*).

Indeed, the new ecohydrological model couples a distributed hydrological model and a vegetation dynamic model (VDM). The hydrological model estimates the soil water balance of each basin cell using the force-restore method, the Philips model for infiltration estimate and the Penman-Monteith equation for evapotranspiration estimate. The VDM evaluates the changes in biomass over time for each cell and provides the leaf area index (LAI), which is then used by the hydrological model for evapotranspiration and rainfall interception estimates. In addition, the model considers the time variability of both ks, by relating its dynamics with the evolution of grass LAI, and v, by relating it with LAI dynamics too.

Case study is the Mulargia basin (Sardinia, basin area of about 70 km2), where an extended field campaign started from 2003, with rain and discharge data observed at the basin outlet, periodic field measurements of soil moisture and LAI all over the basin, and evapotranspiration estimates using an eddy correlation-based tower. The model has been successfully and deeply calibrated for the 2003 and validated for the 2004-2005 period, using both field data and satellite Modis data.

The results demonstrated that the new ecohydrological model predicts well the observed runoff and the land surface fluxes. The comparison between flood predictions generated with and without the inclusion of the time variability of both *k*s and *v*, demonstrated the importance of considering the vegetation dynamic effects on soil water balance and runoff propagation.

References

Montaldo, N., Curreli, M., Corona, R., Saba, A., and Albertson, J. D. (2020). Estimating and Modeling the Effects of Grass Growth on Surface Runoff through a Rainfall Simulator on Field Plots, *Journal of Hydrometeorology*, **21(6), 1297-1310**. https://doi.org/10.1175/JHM-D-20-0049.1