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EHSMu: a new conceptual model for hourly discharge simulation under ecohydrological framework in urban areas

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A parsimonious conceptual lumped model is presented here with the aim of simulating hourly discharge in urban areas. The EHSMu (EcoHydrological Streamflow Model for urban areas) is able to reproduce the discharge at the outlet of an urban drainage system and, at the same time, soil moisture dynamics and evapotranspirative fluxes over vegetated areas within an urban catchment.

In urban areas, rain falling over impervious surfaces is directly transferred towards the drainage system in a time depending on the catchment characteristics, and drainage network geometry. If the rain falls over pervious and vegetated areas the runoff generation is driven by soil moisture content, which in turn is linked to evapotranspiration and leakage. While on one side soil water content determines if rainfall produces saturation excess or a leakage loss, on the other side it constrains the evapotranspirative fluxes, so that, when it approaches to saturation, the actual evapotranspiration tends to the potential one.

The hydrological scheme of the urban catchment follows these premises and consists of three interconnected elements: a soil bucket and two linear reservoirs. The soil bucket epitomizes in two distinct classes different conditions within a catchment: the first interprets impervious areas while the second describes pervious and vegetated soils. The soil bucket is linked to the two linear reservoirs: one is responsible for the runoff within the drainage system, while the other is used to delay the entry of subsurface runoff component into the drainage system.

The surface reservoir is fed by the rain falling on imperviuos areas, by the saturation excess generated over pervious areas and by the delayed contribution arising from the subsurface reservoir, which is solely supplied by leakage pulses. Soil moisture dynamics in the pervious part of the basin, are simulated by a simple bucket model feed by rainfall and depleted by evapotranspiration. The latter component is calculated as a linear function of soil moisture.

The model has been calibrated using Montecarlo simulations on an urban catchment in the United States. This method allows to adapt the conceptual model framework to the catchment characteristics and at the same time to obtain the set of parameters with the higher efficiency in reproducing historical discharge at the outlet.

The proposed model gives reliable estimate of runoff, soil moisture traces and evapotranspiration fluxes. Model outputs could be very useful for urban ecohydrology, because they allow for the simulation of vegetation water stress and consequently the design of sustainable urban green spaces. At the same time the model structure allows to simulate the effects of stormwater management best practices for achieving the hydraulic invariance.