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On the representation of infiltration from the local to the hillslope scale

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An overview of a recent semi-analytical modeling we proposed for the representation of infiltration from the local to the hillslope scale is presented in the light of its use in the hydrological practice. Corradini et al. (J. Hydrol., 1997) developed a conceptual model which extended the application field of the classical formulations earlier proposed through a unified representation of the local infiltration and soil water redistribution under complex rainfall patterns. It enables us to describe the local infiltration into vertically homogeneous soils also for real rainfall patterns that usually involve rainfall hiatus periods with successive reinfiltration starting from an initial profile of soil water content variable with depth. However, for practical applications a role of major interest is ascribed to the hydrograph simulation which requires areal infiltration estimates by low complexity approaches. On the other hand, while Monte-Carlo simulations are sometimes the only recourse when the governing equations are such as to render the mathematical analysis intractable, rainfall-runoff modeling incorporating Monte-Carlo techniques would become inapplicable in the hydrological practice at the basin scale. In this context, Govindaraju et al. (J. Hydrol., 2006) proposed a semi-analytical model for the expected areal-average infiltration rate at hillslope scale, that accounts for spatial heterogeneity of both the saturated hydraulic conductivity, K_s, and rainfall rate, r, then extended by Morbidelli et al. (Hydrol. Proc., 2006) by incorporating the process of infiltration of overland flow running downslope into pervious areas

(run-on process). This model requires a moderate computational effort and can replace Monte-Carlo simulation techniques when random variability of r and K_s is involved. The main limit for the application of the semi-analytical model is the assumption of a vertically homogeneous soil, while the natural soil profile is typically not homogeneous. Local infiltration in layered soils has been scarcely investigated. A general model, based on the numerical solution of a system of ordinary differential equations formulated as an extension of the approach for homogeneous soils by Corradini et al. (J. Hydrol., 1997), was proposed by Corradini et al. (J. Hydrol., 2000). Despite this approach is much simpler to apply than the Richards equation, its extension to areal infiltration becomes of extreme difficulty. Through a simplified version of this model we present here an additional formulation of a preliminary semi-analytical model for the expected areal-average infiltration into layered soils at hillsplope scale.