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Initial soil water content as input to distributed rainfall-runoff models at small basin-scales

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In the mathematical representation through distributed models of the rainfall-runoff transformation at small basin scales, the infiltration process requires to consider the spatial variability of both saturated hydraulic conductivity, K_s, and initial soil moisture content, θ_i. The role of the first quantity is widely recognized and many specific empirical and conceptual/semi-analytical formulations have been proposed in the last ten years in the scientific literature to describe it. With regard to the weight of the spatial heterogeneity of θ_i, contrasting results have been presented.

The main objective of this work is to improve the knowledge of the role of spatial variability of initial soil moisture on the hortonian overland flow generated at small basin scales.

This study relies upon simulations performed by a model that uses a coupled solution of a semi-analytical/conceptual approach for local infiltration and a similarity solution that expresses the spatial behavior of the flow depth as a sine function for overland flow. The entire watershed is partitioned into a sequence of pervious planes and channels, with the surface flow routed in cascade through them.

The model was applied to actual spatial distributions of θ_i, observed in several experimental sites characterized by different land uses, as well as to a uniform value of θ_i assumed equal to the average value or to the value observed in a site characterized by temporal stability. Our results indicate that the surface runoff hydrograph at a basin outlet is generally characterized by a low sensitivity to the horizontal heterogeneity of θ_i, at least in the cases of practical hydrological interest.