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Application of the Connectivity Concept on Soil Surface Micro-topography, and Impact on Runoff Dynamics: Numerical Experiment

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The spatial structure characterization of water flow is essential to improve the prediction of our current hydrological models. Research is needed to understand how connectivity of flow paths develops in time and how they are related to the spatial structure of other attributes like surface topography, soil infiltration capacity, and others.

Classical geostatistical techniques, such as Kriging or conditional simulations, are very popular to generate the spatial structure of hydrological properties. Yet the techniques based on variogram analysis may have limited applicability to predict flow because the spatial connectivity is not explicitly incorporated in the modelling concept.

In this study we investigate the effect of connectivity on surface runoff at a small plot scale. We generated a series of contrasted topographical fields in terms of connectivity, but with similar means, variances and variograms. The impact of surface topography is analysed because it is known to be a driving factor for determining surface flow. In addition, advanced experimental techniques are currently available allowing to characterize the spatial structure of the micro-topography.

We numerically show that when micro-depressions form a connected network, fluxes of high velocity are generated. It increases the mean kinetic energy of the system. On the contrary, when micro-depressions are isolated, they play a major buffer role for runoff, by increasing the storage capacity of the soil surface. This affects the outflow time series. More time is needed for the whole catchment surface water to connect the

outlet, which flattens the hydrogram.

It implicitly shows that the shape of the hydrogram does not depend only on the infiltration characteristics of the soil. Surface storage variability should be taken into account to derive infiltration rates from the hydrogram, taking care that surface storage depends also on connectivity.