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Effect of sheet and rill erosion on overland flow connectivity in bare agricultural plots

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Rill erosion processes generate preferential flow paths that may increase the degree of connectivity of the soil surface and hence strongly modify its hydrological response. However, few studies have tried to quantify the effect of rill development on overland flow connectivity. For this purpose, changes in surface microtopography were monitored on three bare agricultural plots (3 m wide x 10 m long and 11% of slope) in Louvain-la-Neuve (Belgium) under natural rainfall conditions. Digital elevation models of these plots were obtained on a monthly basis over a 1-year period by photogrammetry using the Micmac software. Runoff was collected at the plot outlets. To characterize the hydrological connectivity, a functional connectivity indicator was used, called the relative surface connection function (RSCf). This indicator, which relates the area connected to the outflow boundary to the degree of filling of maximum depression storage (MDS), is fast to compute and was previously shown to be able to capture runoff-relevant connectivity properties. The RSC function was calculated for each DEM and the evolution of overland flow connectivity was quantified and compared to the measured runoff. The results of this study showed that the changes in microtopography resulting from sheet and rill erosion have a strong impact on the hydrological connectivity as reflected in the RSCf. A higher volume of runoff was generated as a consequence of surface sealing and the decrease of the MDS. More rapid runoff initiation was observed as the RSCf evolved from a concave to a convex shape.