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Factors affecting the spatial patterns of soil infiltration capacity at the hillslope scale

Winnie Seifert (1), Anna Coles (2), Willemijn Appels (2), Luisa Hopp (1), and Jeffrey McDonnell (2)

(1) Department of Hydrology, University of Bayreuth, 95440 Bayreuth, Germany, (2) Global Institute for Water Security, University of Saskatchewan, 11 Innovation Boulevard, Saskatoon SK S7N 3H5, Canada

The quantification of soil infiltration capacity (I_c) and its relation to soil properties have been the subject of many studies in the past decades. However, the controls on the spatial organization of infiltration capacity in the landscape are still poorly understood. A better understanding of the patterns of I_c is important since these patterns govern runoff generation and possible threshold runoff responses in low-angled terrain prone to overland flow. In this study we present spatial patterns of I_c on a 5 ha low-angled agricultural field in Southern Saskatchewan and explore above- and below-ground controls.

The study site is located in the semi-arid region of western Canada with a mean annual precipitation of 350 mm. Runoff on these loess soils (Brown Chernozems) is mainly generated during spring snowmelt and occurs as infiltration-excess overland flow over frozen ground. Hillslopes in that region typically have a slope of 1-4%. Infiltration capacity was measured on the 5 ha field in late summer 2013 at 63 randomly distributed locations, using a single ring infiltrometer (Cornell Sprinkle Infiltrometer). Geostatistical analyses were carried out to explore the spatial organization of I_c. Soil depth was measured at 17 locations across the field, the roughness of the soil surface was described for each Ic measuring location and the microtopography on a 456 cm^2 area was determined at 60 locations. Hillslope-scale topographic controls will be examined by correlating terrain indices with the I_c pattern. Furthermore, three dye tracer experiments with Brilliant Blue were carried out at a low, medium and high I_c spot to investigate the question if local scale macroporosity can explain the spatial distribution of I_c.

Infiltration capacities range from 0 to 79.4 mm h^{-1} with a median of 11.7 mm h^{-1} and show no significant correlation with surface roughness, microtopography or soil depth. However, first geostatistical analyses suggest that there is a spatial organization of the I_c pattern. A spherical variogram with a range of 102 m provides the best fit and was used for the ordinary kriging to generate a map of I_c for the agricultural field. The limited data volume and the erratic shape of the experimental variogram hold a high degree of uncertainty that will be examined in detail by further analysis. Confidence intervals for the variogram will be obtained by Monte Carlo methods. Next steps will be to compute various terrain indices from a detailed digital elevation model of the field and test their control on the I_c pattern and to analyze the influence of local scale macroporosity.