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Mapping spatial distribution of preferential flow using earthworms distribution models in combination with tracer infiltration patterns

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Slow matrix flow and rapid by-pass, i.e. preferential flow, result in a large variability of flow in the topsoil. The spatiotemporal infiltration variability in the topsoil strongly determines the distribution of precipitation water to surface runoff, soil moisture storage and rapid percolation to groundwater. Measurement of quantitative indicators for preferential flow and conversion to input parameters for hydrological modelling remain major difficulties in modelling the impact of preferential flow.

Preferential flow often takes place along macropores of biological origin, such as earthworm burrows and root channels. There are three different earthworm types which have different burrowing patterns. These result in different preferential infiltration patterns, varying from rapid deep vertical infiltration to a stronger diffuse distribution of water and solutes in the upper soil layers. Thus the spatial distribution of different ecological earthworm types can help us to understand the spatial variability in preferential infiltration patterns. Geometrical properties of macropores however have in the past proven insufficient to predict preferential flow rates as different numbers and sizes of pores may be hydrologically effective under different conditions. Therefore it is important to link the spatiotemporal distribution of earthworms to the effective preferential flow patterns.

This study is part of the Biopore project, which has as final aim to link spatiotemporal earthworm distribution models with a preferential flow model to obtain an integrated eco-hydrological model. Previous research showed that earthworm presence was the main cause of preferential flow in the study area, the Weiherbach Catchment (Baden-Württemberg, Germany). For this catchment spatiotemporal distribution patterns of earthworms were modelled using soil properties (organic matter content, texture, soil moisture), and topography (slope, elevation) as predictors for earthworm occurrence, abundance and biomass. The results of the spatiotemporal distribution patterns of earthworms are used as indicator for potential spatiotemporal occurrence of preferential flow and are linked to tracer infiltration patterns to obtain information on spatial distribution of effective preferential flow.