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Predicting macropores in space and time by earthworms and abiotic controls

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Macropore flow increases infiltration and solute leaching. The macropore density and connectivity, and thereby the hydrological effectiveness, vary in space and time due to earthworms' burrowing activity and their ability to refill their burrows in order to survive drought periods. The aim of our study was to predict the spatiotemporal variability of macropore distributions by a set of potentially controlling abiotic variables and abundances of different earthworm species. We measured earthworm abundances and effective macropore distributions using tracer rainfall infiltration experiments in six measurement campaigns during one year at six field sites in Luxembourg. Hydrologically effective macropores were counted in three soil depths (3, 10, 30 cm) and distinguished into three diameter classes (<2, 2–6, >6 mm). Earthworms were sampled and determined to species-level. In a generalized linear modelling framework, we related macropores to potential spatial and temporal controlling factors. Earthworm species such as Lumbricus terrestris and Aporrectodea longa, local abiotic site conditions (land use, TWI, slope), temporally varying weather conditions (temperature, humidity, precipitation) and soil moisture affected the number of effective macropores. Main controlling factors and explanatory power of the models (uncertainty and model performance) varied depending on the depth and diameter class of macropores. We present spatiotemporal predictions of macropore density by daily-resolved, one year time series of macropore numbers and maps of macropore distributions at specific dates in a small-scale catchment with 5 m resolution.