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Tracer experiments and simulations on the effect of land use on preferential flow

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Despite intensive research on macropore flow, simulating flow processes in macroporous soil remains challenging due to the various and complex controlling factors. One of these controlling factors is land use and land cover, altering the soil surface and permeability of the topsoil as well as the type of generated macropore network (worm burrows, root channels, shrinking cracks and interaggregate voids). The objective of this study is to investigate the effects of different land use and land cover on the formation of soil structure and significance of macropore flow and to test whether the INfiltration–INitiation–INteraction Model (IN^3M) is capable to predict water flow in macroporous soil under different land use and land cover. IN^3M is a physically based, dual permeability model developed for grassland soils mainly containing earthworm channels, which has shown good agreement with field observations. In order to evaluate the predictive power of the model for different land use types, dye tracer experiments with Brilliant Blue FCF were conducted on 5 sites, each one exhibiting similar soil textural characteristics but differences in land use and management practices (grassland – farmland, tilled and untilled – forest). Each 1.2x1.5 m experimental plot was partitioned into three subplots, which were sprinkled with an intensity of 15mm h-1 and a total infiltration amount of 20, 40, and 60 mm, respectively, to explore the effects of different infiltration amounts on macropore flow processes. During the irrigation, water content changes were continuously measured using time domain reflectometry, with 16 probes vertically installed into the profile at different

depths. After the experiments vertical and horizontal soil sections were excavated and photographed. The images were processed using digital image analysis and the resulting dye pattern classified into distinct flow type categories. The flow types were distinctively different among the sites and could be related to the different biological and physical agents altering the macropore structure. Simulations with IN^{3}M and a multi-criteria validation based on soil water content changes and classified dye patterns revealed certain strengths of the model to capture the observed flow and transport processes in soils dominated by worm burrows, but also revealed weaknesses for other structural features in particular in forests and tilled farmland.