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Can we link spatial patterns of anecic earthworm populations, preferential flow pathways and agrochemical transport in rural catchments?

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Earthworms play a pivotal role in agro-ecosystem functioning by modulating soil structure that significantly influences soil hydraulic properties, organic matter dynamics, and plant growth. This project focuses on anecic earthworms like Lumbricus terrestris which create vertical semi-permanent burrows that function as preferential flow pathways. Preferential flow in macropores is a key process which strongly affects infiltration and may cause rapid transport of pesticides into depths of 80 to 150 cm where they experience a much slower degradation. Therefore, preferential transport is an environmental problem because the topsoil is bypassed, which has been originally thought to act as a filter to protect the subsoil and shallow groundwater. Assessing the environmental risk of pesticides in earthworm burrows and how human management practise feedbacks on that risk requires on the long term the development of an integrated eco-hydrological model.

As a first step towards this goal we will present stochastical approach for predicting the CDF of tracer transport distances at the field scale and catchment scale and demonstrate that this CDF is closely linked to the CDF that characterise the depth distribution of connective worm that link the soil surface and the subsoil. The basic idea is to parameterize a process model based on standard soil physics using a rich field scale database. This “virtual landscape” was used to simulate solute transport for heterogeneous media with and without a population of earthworm burrows for different rainfall forcings. Macropores /earthworm burrows are represented by connected paths of very high saturated hydraulic conductivity, ks, within the range of [10-1 m/s - 10 2 m/s] that are statistically generated based on observed data using a Poisson process and a random walk process. We employed a simple local connectivity measure to characterize the different media and link the resulting depth distribution of connected paths (cf. Section 2.4.1) to the simulated travel distance distribution. Here, the former denotes a structural characteristics of the soil whereas the latter represents the event response. This linkage was achieved by means of an empirical copula (cf. Section 2.4.2) that was conditional to the rainfall forcing. The conditional stochastic model was then obtained by simulations on the marginal travel depth distribution that were conditionally mapped on the depth distribution of connected preferential paths using the conditional empirical copula