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Modelling spatiotemporal distribution patterns of earthworms in order to indicate hydrological soil processes

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Soils provide central ecosystem functions in recycling nutrients, detoxifying harmful chemicals as well as regulating microclimate and local hydrological processes. The internal regulation of these functions and therefore the development of healthy and fertile soils mainly depend on the functional diversity of plants and animals. Soil organisms drive essential processes such as litter decomposition, nutrient cycling, water dynamics, and soil structure formation. Disturbances by different soil management practices (e.g., soil tillage, fertilization, pesticide application) affect the distribution and abundance of soil organisms and hence influence regulating processes. The strong relationship between environmental conditions and soil organisms gives us the opportunity to link spatiotemporal distribution patterns of indicator species with the potential provision of essential soil processes on different scales.

Earthworms are key organisms for soil function and affect, among other things, water dynamics and solute transport in soils. Through their burrowing activity, earthworms increase the number of macropores by building semi-permanent burrow systems. In the unsaturated zone, earthworm burrows act as preferential flow pathways and affect water infiltration, surface-, subsurface- and matrix flow as well as the transport of water and solutes into deeper soil layers. Thereby different ecological earthworm types have different importance. Deep burrowing anecic earthworm species (e.g., *Lumbricus terrestris*) affect the vertical flow and thus increase the risk of potential contamination of ground water with agrochemicals. In contrast, horizontal burrowing endogeic (e.g., *Aporrectodea caliginosa*) and epigeic species (e.g., *Lumbricus rubellus*) increase water conductivity and the diffuse distribution of water and solutes in the upper soil layers. The question which processes are more relevant is pivotal for soil management and risk assessment. Thus, finding relevant environmental predictors which explain the distribution and dynamics of different ecological earthworm types can help us to understand where or when these processes are relevant in the landscape. Therefore, we develop species distribution models which are a useful tool to predict spatiotemporal distributions of earthworm occurrence and abundance under changing environmental conditions. On field scale, geostatistical distribution maps have shown that the spatial distribution of earthworms depends on soil parameters such as food supply, soil moisture, bulk density but with different patterns for earthworm stages (adult, juvenile) and ecological types (anecic, endogeic, epigeic). On landscape scales, earthworm distribution seems to be strongly controlled by management/disturbance-related factors.

Our study shows different modelling approaches for predicting distribution patterns of earthworms in the Weiherbach area, an agricultural site in Kraichtal (Baden-Württemberg, Germany). We carried out field studies on arable fields differing in soil management practices (conventional, conservational), soil properties (organic matter content, texture, soil moisture), and topography (slope, elevation) in order to identify predictors for earthworm occurrence, abundance and biomass. Our earthworm distribution models consider all ecological groups as well as different life stages, accounting for the fact that the activity of juveniles is sometimes different from those of adults. Within our BIOPORE-project it is our final goal to couple our distribution models with population dynamic models and a preferential flow model to an integrated ecohydrological model to analyse feedbacks between earthworm engineering and transport characteristics affecting the functioning of (agro-) ecosystems.