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Systemic modelling of soil functions under the impact of agricultural management

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The increasing demand for food and bio-energy gives need to optimize soil productivity, while securing other soil functions such as nutrient cycling and buffer capacity, carbon storage, biological activity, and water filter and storage. Mechanistic simulation models are an essential tool to fully understand and predict the complex interactions between physical, biological and chemical processes of soil with those functions, as well as the feedbacks between these functions.

We present a systemic soil model to simulate the impact of different management options and changing climate on the named soil functions by integrating them within a simplified system. The model operates on a 1d soil profile and integrates different processes including dynamic water distribution, soil organic matter turnover, crop growth, nitrogen cycling, microbial activity, and root growth.

We present the main features of our model by simulating a long-term field experiment and comparing the simulation results with measured data on yield, carbon, nitrogen and microbial biomass. Additional simulations on soil tillage show the relevance of soil structure for the main soil functions. This is possible due to the dynamic water submodel, which allows for a non rigid pore structure.

To evaluate the simulation results, we propose a combination of our mechanistic modelling with an indicator-based approach for a dynamic soil function evaluation.