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Centre for Soil Research

Evaluating Soil functions based on modeling under the impact of land use

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Introduction

Evaluating agronomic management measures requires estimates of their influence on a range of soil functions, namely biomass production, storage and filtering of water, storage of carbon, nutrient cycling and habitat for biodiversity.
For each function there is a site specific potential, meaning the degree of fulfillment of the function under optimal conditions. For the actual situation, the conditions are normally not in optimum, and the degree of fulfillment is characterized as the state. Given a specific management and the development of the state we can describe the influence of this management on each specific soil function.

Introduction

There is a great variety of evaluation procedures. Most of them have a semi-quantitative indicator scheme that leads to a specific soil index. An overview can be found in "Quantitative Evaluation of Soil Functions: Potential and State" (Vogel et al., 2019, Frontiers in Environmental Science) With the tool of modeling we can address some of the functions more quantitative.

The Bodium model

See presentation EGU2020-15243 for the model we apply.

Evaluating production function

The model calculates crop yields. This enables a direct formulation of indicators. As the indicator has to take into account different unpredictable weather situations the indicator is based on a series of weather scenarios for the given site. This is taken from historical data sorted by the wetness (precipitation - ETP) and then selected years from dry to wet are used for modeling an indicator crop (winter wheat). The average yield forms then the indicator. This is calculated for the currently observed conditions (state), after a series of contrasting management scenarios and the then changed state (wih different structure and carbon content). And for a set of optimized state parameters (favorable structure, maximized carbon content) to obtain the potential.

Evaluating water storage and filtering

Water storage and filtering has two major components: surface runoff, which creates a threat for flooding, and deep percolation, which forms the groundwater recharge and nitrate leaching. The model calculates both components and can give estimates for different management scenarios.

Carbon storage

SOM turnover is a central part of the Bodium model. Under the chosen management the development of the carbon stock can be calculated directly. For the potential there is an upper limit depending on climate and soil texture.

Habitat for biodiversity

As biodiversity is not an explicit part of the model, there is no direct quantitative index that can be derived. Here we have to use the existing indices, and feed them with the soil's altered state variables due to different management practices.