Definition and regionalization of crop production systems on large scales - an integrated approach for environmental modeling and assessment

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Global socio-economic and climate change lead to an increasing number of studies that analyze and evaluate the large-scale impact of land use and land management on natural resources and ecosystem services. Such studies typically struggle with the heterogeneity of agricultural crop production systems at larger spatial scales and the resulting need for generalization. But at the same time there is also a need for differentiation of these various systems that allows the necessary separation of their individual environmental impacts. In consequence, a balance between both needs has to be found, especially under conditions of limited data availability.

To address these issues, we introduce an integrated approach which differentiates agricultural crop production systems on large scales, using commonly available data. Within a modular design, we define and regionalize crop production and crop rotations, farm types and tillage systems on the example of Central Germany, comprising three federal states. Regarding fertilizer systems, the management of individual crops includes options for conventional (mineral fertilizer, manure) as well as new types of fertilizer (biogas digestate). The definition and regionalization of quantities (e.g. crop yields, amount of fertilizer applied) is based on regional statistics and calculations of area-based balances. Suitable crop rotations are selected from a pool of crop rotations currently applied within the region. The design of the selection method ensures a minimum amount of crop rotations while simultaneously matching agricultural statistics (in terms of spatial and temporal distribution). Crop management information is stored in a database and can be combined with crop rotation data according to the demand of the individual project. An exemplary set-up of the methodology will be presented for the region of Central Germany.

The modular design ensures flexibility - the level of detail and the regional differentiation can be adjusted according to individual demands and data availability of the individual projects. The approach can be used for different forms of environmental modeling and assessment which require a differentiation of agricultural crop production systems on large scales, like (eco)hydrological (e.g. water quality & availability, soil erosion) and crop growth modeling (e.g. bioenergy, yield gaps) or environmental assessments (e.g. LCA).