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Biophysical landscape interactions: Bridging disciplines and scale with connectivity

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The combination of climate change, population growth and soil threats, such as carbon loss, biodiversity decline or erosion amongst others , increasingly confront the global community [1]. One of the major challenges in studying processes involved in soil threats, landscape resilience, ecosystem stability, sustainable land management and the economic consequences, is that it is an interdisciplinary field [2], that needs less stringent scientific disciplinary boundaries [3]. As a result of disciplinary focus, ambiguity may arise on the understanding of landscape interactions, and this is especially true in the interaction between a landscape's physical and biological processes [4]. Another important aspect in biophysical landscape interactions are the differences in scale related to the various processes that play a role in these systems. While scaling of environmental processes is possible, as long as the phenomena at hand can be described by the same set of differential equations [5], biophysical landscape interactions pose problems for scaling approaches.
Landscape position and land use impact the coupled processes in soil and vegetation. Differences in micro-behavior, driven by the interplay of heterogeneous soil and vegetation dynamics, impact emergent characteristics across a landscape. A complicating factor is the response of vegetation to changing environmental conditions, including a possible and often unknown time-lag. By altering soil conditions, plants may leave an imprint in the landscape that remains even after vegetation has disappeared due to e.g. drought, wildfire or overgrazing. Plants also respond biochemically to their environment, while the models used for hydrology are often based on physical interactions. Gene-expression and genotype adaptation may further complicate our modelling efforts in for example climate change impacts.

What are we missing by not having more connectivity in our thinking, and what we can solve? We think that integrated concepts of biophysical landscape interactions are needed to evaluate soil water availability in relation to the stability of natural vegetation, especially in the perspective of soil threats, population growth, climate change, and global water scarcity. An integrated concept can only be established by bridging the gap between several disciplines, but needs to be appealing to those disciplines at the same time. As evidence suggests interdisciplinary work is more challenging to get funded [6]. The key aspect of the connectivity concept is that it can create pathways for feedbacks which are so often missing in soil and water models. Connectivity could thus play an important role in bridging disciplines and scales.

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