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New possibilities for soil and landscape evolution modelling by coupling LAPSUS and MILESD

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The formation of soils and evolution of landscapes over time are closely coupled. Erosion and lateral sediment redistribution impact soil profiles in hilly and mountainous areas and changes can be very rapid due to human-induced land use changes. On the other hand, key soil properties, such as depth and texture, are crucial for understanding the geomorphic response of landscapes. Also for understanding biogeochemical fluxes at the soil profile and landscape scale, a coupled approach is crucial. At present, it is hypothesized that many of these processes are controlled by thresholds and respond in a non-linear manner. There is therefore an increasing need for models that integrate both processes and mimic this complexity.

Here, we present a new coupled model of the co-evolution of soils and landscapes. This model is based on landscape evolution model LAPSUS and includes the soil forming processes represented in the model MILESD. The model allows the formation of a vertical soil profile with a user-specified number of layers. The main soil forming processes included are soil formation from bedrock, physical and chemical weathering, bioturbation, clay neoformation and clay lessivage. Landscape evolution processes represented are water erosion, tillage erosion, landsliding, creep, solifluction and simplified tectonics.

We analyze the effect of different climatic and land use scenarios on 1) the spatial and vertical distribution of key soil properties 2) the dynamics of landscape evolution and feedbacks of soil properties on erosion 3) the temporal dynamics of sediment flux, sediment grading and carbon fluxes.
The results clearly illustrate the potential of coupling soil and landscape formation for an improved understanding of long-term soil and landscape dynamics.