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Assessment of soil parent material formation in periglacial environments through medium scale landscape evolution modelling

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Soil parental materials represent the weathering product of any surficial geological substrates comprising in-situ fragmented and dissolved rocks, unconsolidated sediments of various types and origins, or even paleosoils. Weathering, erosion, transport and accumulation processes of geological materials governing the formation of soil parent materials display a highly complex non-linear behaviour at larger spatial scales over smaller geological time periods (< 50.000 years) in lithologically complex settings. This is particularly evident in periglacial environments where regional allochthonous sediment supply contributes to soil parent material formation.

We propose a GIS implementation of a landscape evolution model (LEM) for the spatiotemporal investigation of soil parent material evolution following a lithologically differentiated approach. The well-established LEM tool GOLEM has been adapted and realized as a module for the open-source GIS SAGA to operate in a spatially distributed framework, taking advantage of the highly developed capabilities of SAGA for morphometric digital terrain analysis. The LEM is driven by high-resolution paleo-climatic data (temperature, precipitation) representative for periglacial areas in Northern Germany over the last 50.000 years. The initial conditions of the LEM are determined for a test site by a digital terrain model and a geological model. The geological model was parameterized through geological field data derived from rock mass rating procedures and soft sediment analyses to account for a lithologically differentiated LEM set up with respect to first-order mechanical properties of both rock-type and unconsolidated lithologies. Weathering, erosion and transport functions of the LEM are calibrated using the extrinsic (climatic) and intrinsic (lithology) parameter data. First results indicate that our differentiated LEM-based approach displays some evidence for the spatiotemporal prediction of important soil parental material properties (e.g., thickness, structure, texture, and composition). However, the results have to be validated against field data, and the influence of discrete events (landslides, floods) has to be evaluated.