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Quantification of initial 3D sediment mass balance components in an artificially-created hydrologic catchment using GOCAD

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A 6-ha-size hydrologic catchment was created as an experimental field observatory to study interactions between structures and processes during initial stages of geo-ecosystem development. With a low permeable clay liner at the basis, most of the catchment was formed from predominately sandy sediments of quaternary origin. After completion of the construction, the incipient (geo-, bio-, and pedological) processes are initially affected by the spatial distribution and mineralogical properties of the primary sediments. Such sediment structures have hardly been visualized and quantified in 3D.

This study aims at the quantification of the spatial and temporal dynamics of erosive mass relocations and their interdependencies with sediment properties. The sediment mass balances approach is based on aerial and digitized maps of temporary and initial surfaces.
2D horizontal digital elevation models (DEMs) of the surface and the subsurface clay layer are used to construct a 3D numerical grid of the catchment's initial spatial structure using the 3D-GIS software GOCAD. Physical and chemical soil properties obtained from borehole samples are assigned to this model and interpolated onto the 3D grid. A temporal sequence of surface DEMs, constructed from photogrammetric and high-precision laser scanning data, is used to repeatedly update the 3D grid. Terrain attributes of the different surfaces are computed and included in the model. The volumetric changes in space and time are quantified and related to material properties to obtain the mass changes. Correlations between terrain attributes, material properties and mass changes are explored.

First results show that both sediment structures and mass translocations differ between the western and eastern part of the catchment. Thus, by separately quantifying mass balances within subregions composed of different source materials, correlations can be drawn between material properties and sediment dynamics. The 3D structure model so allows a first approximation of erosion-affected surface structural dynamics.