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Generating the 3D internal sediment structure of an artificial catchment

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During the pioneering phase of catchments, the initial spatial distribution of structural features like sediment texture and bulk densities determines the structural dynamics to a great extent. During this time, the specific internal structuring governs both superficial and subsurface processes. Realistic information on the internal structural framework and the 3D spatial distribution of sediment properties is thus vital for the correct interpretation of observed structural dynamics.

The objective of this study was the reconstruction of initial internal structural features, exemplified for a small hydrological catchment. The study was carried out for the artificially created catchment “Chicken Creek” near Cottbus, Germany, where mining spreader technology generated characteristic sediment structures.

Digital Elevation Models (DEMs) derived from photogrammetric surveys were used for the construction of the delimiting surfaces. In the following step, a 3D-volume body (SGrid) was created with the 3D modelling software GOCAD.
With a structure generator, 2D digital representations of spoil cones as the basic structural elements were generated. The structure generator incorporates specific bulk density distributions depending on drop height and angle, as well as textural and mineralogical differentiation due to segregation processes. The program is based on theoretical assumptions and field studies of soil cone profiles. Textural and mineralogical information of the outcrop side are used. The 2D cross sections are distributed along the spreader trajectories. Imported into the GOCAD SGrid as property values, the structures were verified by comparisons with on-site soil profiles and bore hole information and results from non-invasive geophysical investigations.

The 3D catchment model with internal structure will serve as a basis for deriving the 3D-distributions of hydraulic properties for hydrological modelling and may help to better understand processes of the pioneering phase.