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A 3D model describing the initial structure of an artificial hydrological catchment

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The initial development stages of artificially constructed hydrologic catchments are characterized by the absence of vegetation, soil organic matter and soil horizons. This results in increased surface runoff and favors erosion processes that dominate the initial phase. Hydraulic conditions on artificial catchments thus are governed by rapidly changing surface structures as well as by the primary internal structural framework. Contemporary hydrological modeling does not consider any dynamic change of relevant structural features but rather assumes a stable, invariant landscape.

The objective of this study was the digital visualization and quantitative description of the initial state and its early structural dynamics, exemplified for the small artificial hydrological catchment “Huehnerwasser” near Cottbus, Germany.

Photogrammetric surveys of surface and internal structural units (clay basis liner) during the construction phase provided spatially and temporally resolved data for digital elevation models (DEM). Interpolated physical and chemical soil properties obtained at a borehole grid (e.g., texture) are used for the visualization of spatial distribution of relevant (hydraulic) parameters. The data are merged in a database and visualized in the 3D-GIS application GoCAD. The specific technological construction processes determines the internal structure of the artificial catchment. Resulting differences in bulk density and texture are supposed to have considerable impact on hydraulic properties. A structure generator program was implemented to reproduce the initial structure of the sediment layer as closely as possible. Results of the digital structure generation are checked with non-invasive geophysical measurements, on-site bore holes data and off-site 2D vertical spoil exploration. The accuracy of structure generator results will be compared with predictions of different interpolation methods.

Thus, the structure model will serve as a basis for deriving the 3D-distributions of hydraulic properties for the modelling of surface runoff, erosion and soil water and solute movement. Continuous measurements of the dynamic development of structural features like surface relief, vegetation patterns and crust formation will be used to create time-slices that allow a first estimation of the temporal and spatial change of structural features and connected hydraulic parameters. The combined 3D analysis of different parameters at different points of time allows the deduction and classification of volumes dominated by certain processes and their spatial development over time.