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Groundwater flow behaviour during the initial development phase of an artificial catchment

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Artificially created, spatially and structurally well defined hydrological catchments are suitable study sites for hydrological and ecosystem research. One of the largest artificial catchments named “Chicken Creek” with clearly defined boundary conditions and extended monitoring facilities was set up on a dump site from opencast mining activities in Eastern Germany. The catchment, left to undisturbed succession, enables the observation of ecosystem development from the very beginning.

Precipitation as the only source of water input is the dominating driving force for the hydrological processes in the initial development phase. Due to the initial absence of vegetation or organic structures, the morphological and hydrogeological properties of the artificial catchment control the runoff and storage processes. In case of the Chicken Creek catchment, they are given by the construction design and technology.

In mature natural catchments, the groundwater flow system has normally achieved a dynamic equilibrium stage. In the newly constructed artificial catchment, the groundwater body is just evolving by infiltrating and percolating precipitation which fills the pore volume of the initially unsaturated catchment body. The saturation process has started above the underlying horizontal clay layer that is acting as lower catchment boundary. The observed trend of rising groundwater table superposed by seasonal fluctuations indicates a groundwater recharge higher than the drainage. During the last four years, the filling process is extenuating and an equilibrium between groundwater recharge and drainage is establishing. Groundwater exfiltration preferentially occurs in new gully structures formed by precipitation induced erosion processes.

A groundwater model is set up to simulate the groundwater dynamics during the initial phase of the catchment development. Based on the theoretical consideration of initial homogeneity and isotropy, hydrogeologically relevant structures, patterns and their effects on the groundwater system shall be introduced and their effects evaluated in comparison with the field observations. The modelling aims at the identification and description of different flow statuses, threshold behaviour and flow patterns. Observation and simulation results shall be presented.