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State transitions and feedback mechanisms control hydrology in the constructed catchment ′Chicken Creek′

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Landscapes and ecosystems are complex systems with many feedback mechanisms acting between the various abiotic and biotic components. The knowledge about these interacting processes is mainly derived from mature ecosystems. The initial development of ecosystem complexity may involve state transitions following catastrophic shifts, disturbances or transgression of thresholds.
The Chicken Creek catchment was constructed in 2005 in the mining area of Lusatia/Germany to study processes and feedback mechanisms during ecosystem evolution. The hillslope-shaped 6 ha site has defined boundary conditions and well-documented inner structures. The dominating substrate above the underlying clay layer is Pleistocene sandy material representing mainly the lower C horizon of the former landscape. Since 2005, the unrestricted, unmanaged development of the catchment was intensively monitored.
During the ten years since then, we observed characteristic state transitions in catchment functioning driven by feedbacks between original substrate properties, surface structures, soil development and vegetation succession. Whereas surface runoff induced by surface crusting and infiltration dominated catchment hydrology in the first years, the impact of vegetation on hydrological pathways and groundwater levels became more and more evident during the last years. Discharge from the catchment changed from episodic events driven by precipitation and surface runoff to groundwater driven. This general picture is overlain by spatial patterns and single episodic events of external drivers.
The scientific value of the Chicken Creek site with known boundary conditions and structure information could help in disentangling general feedback mechanisms between hydrologic, pedogenic, biological and geomorphological processes as well as a in gaining a more integrative view of succession and its drivers during the transition from initial, less complex systems to more mature ecosystems. Long-term time series of data are a key for a better understanding of these processes and the effects on ecosystem resilience and self-organization.