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The role of geodiversity in ecosystem development

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Besides biodiversity, geodiversity is an important constituent of complex ecosystems. We define geodiversity here mainly as substrate and surface properties and topography.

Especially during initial stages of young ecosystems, the geodiversity of a site or landscape may have a lasting impact on dominating abiotic feedback mechanisms that set the stage for further ecological development.

The Chicken Creek catchment was constructed in the Lusatian mining area as a research platform to study initial ecosystem development at the landscape scale. The 6 ha site was formed as a hillslope with 2 to 3.5 % inclination. Up to 3.5 m of Pleistocene sands were dumped as an aquifer on top of a 1-2 m clay layer. The construction process using large-scale mining machinery resulted in slight differences in substrate properties in different parts of the catchment reflecting the natural variation in overburden material that was used for aquifer construction.

After completion of the construction in 2005, a cross-disciplinary long-term monitoring program was initiated to record major environmental parameters adapted to the development of the site. No amelioration, fertilization or planting was carried out to allow for primary succession.

Time series of environmental data recorded since 2005 revealed that the geodiversity of the initial site affected a number of both abiotic and biotic processes (e.g. surface runoff and erosion intensity, top soil development, colonization by plant functional traits, soil moisture and groundwater patterns, formation of biological soil crusts).

During its first 15 years, the Chicken Creek experimental catchment showed a very dynamic development. Whereas the abiotic geosystem of the first 2-3 years was characterized by heavy erosion and sediment transport, primary succession by invading vegetation and the unexpected formation of soil crusts within only a few years resulted in biotic-abiotic feedbacks that controlled catchment hydrology.

Our data indicate that even minor variations in initial substrate characteristics (e.g. texture) and stochastic single events like thunderstorms can have lasting impacts on the geomorphological, hydrological and biological development of the catchment.