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Hydrogeochemical signatures of catchment evolution – the role of calcium and sulphate release in the constructed Hühnerwasser ("Chicken Creek") catchment

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The constructed Hühnerwasser ("Chicken Creek") catchment is an ecohydrological system in an initial state of development. The catchment with an area of 6 ha was built up from quaternary sediments in the post-mining landscape of Lusatia in Eastern Germany and serves as a critical zone observatory for detecting ecosystem transition. The soil substrate is characterized as sands to loamy sands with low carbonate contents but significant amounts of gypsum in the sediments of the catchment. The catchment undergoes a strong transition from an abiotic system in the initial years to a system with growing influence of biota. Concerning the hydrology, a regime shift from surface runoff to groundwater flow dominated processes is significant.

It is of interest, whether the catchment transition is also reflected by hydrogeochemical indicators. We assume gypsum dissolution as dominant process at the catchment scale. In order to investigate the hydrogeochemical evolution of the catchment we analysed electric conductivity, calcium and sulphate concentrations and pH-values of biweekly composite samples from 2007-2013 of the atmospheric deposition, of runoff and soil water. The two observation points in the flowing water represent surface runoff and groundwater discharge respectively. Soil water has been analysed at four soil pits in three depths. The monitoring data were provided by the Research Platform Chicken Creek (https://www.tu-cottbus.de/projekte/en/oekosysteme/startseite.html).

From the macroscopic data analysis we found an exponential decay of the electric conductivity, calcium and sulphate concentrations in the flowing waters and some of the soil pits. In the flowing water, the decrease slope of the electric conductivity and the calcium and sulphate concentrations is almost identical. The calcium / sulphate molar ratio as an indicator of gypsum dissolution is almost equal to one up to 2010, afterwards more calcium than sulphate is released. The pH-values in the flowing and soil water are generally higher than in the atmospheric deposition, they do show variabilites but no trend behaviour. The time series analyses showed that the interannual variability of the hydrogeochemical properties is less pronounced in the first years of ecosystem development than in the later years.

This leads to the conclusion, that in the first years, gypsum dissolution is the major source for calcium and sulphate in the soil and the flowing waters. The increasing interannual variability and changes in the calcium / sulphate ratio in the later years might be interpreted as hydrogeochemical response to the development of vegetation and acidification due to the development of the rhizosphere.