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Nested investigation of subsurface connectivity between hillslopes and streams

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The high spatial variability of the subsurface, and thereby the spatial variability of its hydrological characteristics, still pose a great challenge to in-depth understanding and prediction of subsurface flow and the mechanisms that dynamically connect hillslopes and streams. Even though physical processes in porous media are theoretically very well understood, predicting hillslopes' responses to a specific (precipitation) event can be very intricate, due to the structural heterogeneity of real hillslope-stream systems.

In the here presented study (carried out as part of the Catchments As Organized Systems (CAOS) research unit) we assess the linkage between hillslopes and streams via subsurface flow paths. This linkage can also be called "Connectivity", which describes separate regions within a certain catchment as being in a linked state – or not – via water flux. We focus our experimental efforts on several hillslopes with differing geological and morphological properties and seek for indications of connectivity at the hillslope/stream reach scale. These hillslopes are instrumented with soil moisture sensors and observation wells measuring shallow groundwater levels, electric conductivity and temperature continuously. This gives us a first indication of subsurface storage fluctuations and hillslope responses. This setup is extended at selected sites by additional observation wells and electrical resistivity tomography (ERT) transects which are measured in time lapse mode. Hillslope scale forced flow through experiments, where subsurface water flux is induced from upslope, will give an indication for a potential maximum of connectivity in a more or less controlled, yet real, environment. First results of these experiments are reported alongside with response patterns to natural rainfall events.

The aim is to identify hydrological and morphological controls on subsurface connectivity depending on the site's characteristics, the system's current state and the forcing during an event. Possible threshold behaviour as well as different qualities of connectivity (channelled vs. diffuse) should be detected and distinguished.