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Biogenic structures and their controls on water flow & storage from plot to meso-catchment scale

Loes van Schaik (1,2), Anne-Kathrin Schneider (2), Anne Zangerlé (3), Jana Eccard (4), and Boris Schröder (2)

(1) University of Potsdam, Institute of Earth and Environmental Sciences, Potsdam, Germany (schaik@uni-potsdam.de), (2) Technical University of Braunschweig, Environmental Systems Analysis, Institute of Geoecology, Braunschweig, Germany, (3) Landscape Ecology, Technische Universität München, Freising-Weihenstephan, Germany, (4) University of Potsdam, Institute of Biochemistry and Biology , Potsdam, Germany

A high spatio-termporal variability in water flow and storage, i.e. preferential flow, can influence local infiltration patterns, but also the distribution of water to runoff, soil moisture, groundwater and subsurface stormflow. Preferential flow can occur from plot scale to catchment scale and is often mainly determined by soil structure. In the past decades the research on preferential flow and inclusion of preferential flow into hydrological models has strongly improved our understanding of hydrology. The quantification of soil structure and the parameterization of preferential flow for hydrological models however remains a major challenge.

A large part of soil structure is of biogenic origin: biopores and bioaggregates. The spatial distribution of the different organisms which create biogenic soil structures depends on soil habitat factors. At the same time these organisms actively change the soil physical or chemical processes thereby influencing the soil habitat. This results in a clear feedback loop between the soil processes and the abundance of soil organisms. Therefore in the CAOS Subproject J we propose to use the spatial distribution patterns of soil organisms to describe the spatial differences in soil structure and to support the parameterization of hydrological models at different scales: plot scale to catchment scale. Therefore at the plot scale the local bioactivity can be coupled to infiltration patterns. The spatial pattern of species abundance can be used to describe the connectivity of macropore networks at hillslope scale. And for the catchment scale, species distribution models can help to extrapolate the knowledge about the hydrological processes to areas with limited measurements, based on the relationships between bioactivity and hydrological processes from the studied sites.

Due to the aforementioned feedback loop between bioactivity and soil processes a future change in climate or land-use can have both a direct as well as an important indirect influence on hydrological processes: through a change in bioactivity resulting in a change in soil structure. The inclusion of these feedbacks in hydrological modeling is thus important to be able to make reliable predictions of future changes in catchment scale hydrology.