Geophysical Research Abstracts
Vol. 19, EGU2017-15424, 2017
EGU General Assembly 2017

From one plot to many and from hillslopes to streams: Improving our understanding of catchment hydrology with a multi-scale experimental approach

Theresa Blume (1), Markus Weiler (2), Lisa Angermann (1), Daniel Beiter (1), Sibylle Hassler (3), Nils Kaplan (2), Ernestine Lieder (1), and Matthias Sprenger (4)

(1) GFZ German Research Centre for Geosciences, Section 5.4 Hydrology, Potsdam, Germany (blume@gfz-potsdam.de), (2) Chair of Hydrology, University of Freiburg, Germany, (3) Institute for Water and River Basin Management, Karlsruhe Institute of Technology (KIT), Karlsruhe, Germany, (4) School of Geosciences, University of Aberdeen, UK

Sustainable water resources management needs to be based on sound process understanding. This is especially true in a changing world, where boundary conditions change and models calibrated to the status quo are no longer helpful. There is a general agreement in the hydrologic community that we are in need of a better process understanding and that one of the most promising ways to achieve this is by using nested experimental designs that cover a range of scales.

In the here presented study we argue that while we might be able to investigate a certain process at a plot or hillslope in detail, the real power of advancing our understanding lies in site intercomparison and if possible knowledge transfer and generalization. The experimental design of the CAOS observatory is based on sensor clusters measuring ground-, soil and stream water, sap flow and climate variables in 45 hydrological functional units which were chosen from a matrix of site characteristics (geology, land use, hillslope aspect, and topographic positions). This design allows for site intercomparisons that are based on more than one member per class and thus does not only characterize between class differences but also attempts to identify within-class variability.

These distributed plot scale investigations offer a large amount of information on plot scale processes and their variability in space and time (e.g. water storage dynamics and patterns, vertical flow processes and vadose zone transit times, transpiration dynamics and patterns). However, if we want to improve our understanding of runoff generation (and thus also of nutrient and contaminant transport and export to the stream) we need to also understand how these plots link up within hillslopes and how and when these hillslopes are connected to the stream. And certainly, this is again most helpful if we do not focus on single sites but attempt experimental designs that aim at intercomparison and generalization. At the same time, the investigation of hillslope-stream connectivity is extremely challenging due to the fact that there is a high 4-dimensional variability of the involved processes and most of them are hidden from view in the subsurface. To tackle this challenge we employed a number of different field methods ranging from hillslope scale irrigation and flow-through experiments, to in depth analyses of near stream piezometer responses and stream reach tracer experiments, and then moving on to the mesoscale catchment with network wide investigations of spatial patterns of stream temperature and electric conductivity as well as of the expansion and shrinkage of the network itself. In this presentation we will provide an overview of the rationale, approach, experimental design and ongoing work, the challenges we encountered and a synthesis of exemplary results.