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Controls of catchments‘ sub-storage contributions to dynamic water quality patterns in the stream network

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Water quality is usually observed either continuously at a few stations within a catchment or with few snapshot sampling campaigns throughout the whole stream network. Although we know that the depletion of catchment sub-storages can vary throughout the stream network according to their actual water content (spatial variability of actual storage conditions can be caused amongst others by unevenly distributed rainfall, storage size or spatial differences in soil characteristics and land use), we know little about the impact of this process on spatial water quality patterns. For summer low flow recession periods, when stream water composition can be crucial for aquatic ecosystem conditions and the exceedance of water quality thresholds, knowledge on the controls of the dynamic interplay of catchment storages and stream water composition might improve water quality management and the implementation of corresponding mitigation measures.

We studied this process throughout the stream network of a first-order agricultural headwater catchment in south-western Germany during two summer low flow recession periods. The underlying geology of the study area is a deep layer of aeolian loess, whilst the dominating soil is a silty calcaric regosol with gleizations in the colluvium. The land use in the catchment is dominated by viniculture (63 %) and arable crops (18 %). Due to the dense drainpipe network within the catchment we could identify 12 sub-catchments contributing during summer low flow recession periods to total stream discharge. We continuously observed discharge, electrical conductivity and water temperatures for 8 of the sub-catchments and at the catchment outlet. This data set was accomplished by 10 snapshot campaigns where we sampled for water temperatures, electrical conductivity, major ions, pH and O_2 throughout the stream network. Using either discharge concentration relationships or time dependent functions, we derived continuous export rates for all measures in all sub-catchments and at the catchment outlet. We compare the temporal variability of sub-catchment ion-loads and local instream water composition and determine the sub-catchment contributions to total catchment export. GIS information on the stream network, pedology, geology, topography and land use was the used to infer the properties of the sub-catchments with high, low or variably dominating contributions to stream network water composition and total catchment export. Regarding the effect of sub-catchments on diffuse pollution (nitrate emissions) we found that land use was more important than sub-catchment size. For more groundwater dominated sub-catchments the impact on water quality decreased with increasing discharge, while for sub-catchments fed by near surface storages positive relations between ion loads and discharge were identified. These results show that interpretations of water quality observed at the catchment outlet should be made with regard to the characteristics of dominating catchment sub-storages.