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Space/time dynamics of solute and particulate export mechanisms in a mesoscale humid catchment

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Understanding the interplay of spatial organization of geomorphological catchment characteristics, land uses and the temporal variation of associated hydrological processes regarding their effect on solute and particulate export mechanisms across scales remains challenging for many catchments.
These processes have been studied in the mesoscale research catchment Olewiger Bach (24.6 km^2, tributary to the river Mosel, Germany) using a nested catchment approach. The catchment is structured into three spatial units with distinct geomorphological features and land uses along the stream network: field crops and intensive agriculture dominate the upper catchment area on the high plateau of the devonic Hunsrueck-slate while the downstream area is densely covered with urban settlements that contribute via mixed and separated sewer overflows to stream discharge. The steep valley, which is connecting both parts, has forested slopes and grasslands in the riparian zone. Three discharge gauging and water quality stations (T, EC & SSC) accompanied by two measurement-clusters for the quantification of groundwater-surface water interactions have been equipped along this landscape gradient operated with observation frequencies of five to ten minutes. Four public climate stations in and around the catchment area complete the setup.
Our analysis shows that the quantitative contribution to stream discharges and associated water quality dynamics differs between the units distinctively: The urban parts of the catchment contribute year round with flashy hydrographs associated with large suspended sediment loads and low dissolved ion concentrations to the stream discharge. During the dry season, the upper parts of the catchment react similarly with fast rainfall driven surface flow reactions and low dissolved ion concentrations. The seasonal saturation of catchment storages in the upper and middle section of the catchment changes the discharge generation processes and associated solute and particulate transport mechanisms clearly. The relative proportion of stream flow from the upper sections increases up to over 90 percent during single runoff events, which are characterized by comparably ion rich delayed interflow flood waves with peak discharges two days after the rainfall event. The highly variable exchange fluxes between groundwater and surface waters express these conditions as well: for the middle section, we found over seven years an increase of upwelling flow conditions from dry to wet season from about 15 % to 30 % of the time. Generally, our study highlights the importance of temporally differing spatial locations of water, solute and particulate sources within catchments for the formation of observable water quality dynamics in downstream areas.