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Spatial patterns of stream temperatures and electric conductivity in a mesoscale catchment

Ernestine Lieder (1), Markus Weiler (2), and Theresa Blume (1)

(1) GFZ Helmholtz Centre Potsdam, 5.4 Hydrology, Potsdam, Germany (elieder@gfz-potsdam.de), (2) Chair of Hydrology, Albert-Ludwigs-University of Freiburg, Germany

Stream temperature and electric conductivity (EC) are both relatively easily measured and can provide valuable information on runoff generation processes and catchment storage.This study investigates the spatial variability of stream temperature and EC in a mesoscale basin. We focus on the mesoscale (sub-catchments and reach scale), and long term (seasonal / annual) stream temperature and EC patterns.

Our study basin is the Attert catchment in Luxembourg (288km^2), which contains multiple sub-catchments of different geology, topography and land use patterns. We installed 90 stream temperature and EC sensors at sites across the basin in summer 2015. The collected data is complemented by land use and discharge data and an extensive climate data set. Thermal sensitivity was calculated as the slope of daily air temperature-water-temperature regression line and describes the sensitivity of stream temperature to long term environmental change. Amplitude sensitivity was calculated as slope of the daily air and water temperature amplitude regression and describes the short term warming capacity of the stream.

We found that groups with similar long term thermal and EC patterns are strongly related to different geological units. The sandstone reaches show the coldest temperatures and lowest annual thermal sensitivity to air temperature. The slate reaches are characterized by comparably low EC and high daily temperature amplitudes and amplitude sensitivity. Furthermore, mean annual temperatures and thermal sensitivities increase exponentially with drainage area, which can be attributed to the accumulation of heat throughout the system. On the reach scale, daily stream temperature fluctuations or sensitivities were strongly influenced by land cover distribution, stream shading and runoff volume. Daily thermal sensitivities were low for headwater streams; peaked for intermediate reaches in the middle of the catchment and then decreased again further downstream with increasing drainage area.

Combining spatially distributed time series of stream temperatures and EC with information about geology, landscape and climate provides insight into the underlying hydrological processes and allows for the identification of thermally sensitive regions and reaches.