EGU21-15439
https://doi.org/10.5194/egusphere-egu21-15439
EGU General Assembly 2021

Physiographic controls on pre-event hydrological states and hydrological response to extreme precipitation in the Alzette River Basin, Luxembourg

Carol Tamez Melendez[1], Judith Meyer[1,2], Audrey Douinot[1], Günter Blöschl[3], and Laurent Pfister[1,2]
[1]Environmental Research and Innovation department, Catchment and eco-hydrology research group, Luxembourg Institute of Science and Technology
[2]University of Luxembourg, Faculty of Science, Technology and Medicine
[3]TU Vienna, Institute of Hydraulic Engineering and Water Resources Management

Flash flood events have caused massive damage on multiple occasions between 2016 and 2018 in several catchments in eastern Luxembourg. This region is very well known for being exposed to large-scale winter floods, commonly triggered by long-lasting advective precipitation events related to westerly atmospheric fluxes. However, flash floods - a truly exceptional phenomenon in this region - are have solely occurred in summer in response to intense convective precipitation events. Thus, because of the rare occurrence and local character of this type of events, the mechanisms eventually controlling a flash flood-type response of a catchment remains poorly understood.

Here, we focus on four main objectives: i) the role that physiographic characteristics play on the spatial variability of pre-event hydrological states (as expressed via storage) across a set of 41 nested catchments located in the Sûre River basin (4,240 km^2), Luxembourg, ii) the hydrological response to precipitation controlled by those pre-event hydrological states, iii) the responsivity (resistance) and elasticity (resilience) of the catchments to global change, and iv) the relation between water yields and the offsets from Budyko curve and its related energy limits.

The area of interest is not only characterised by a homogenous temperate oceanic climate but also by heterogeneous physiographical conditions and land use, which makes it ideal for this study. We used 8 years' worth hydrological data (precipitation, discharge and potential evapotranspiration) to calculate the increments of the water balance and determine the maximum storage capacity and storage deficits. Second, we used the relationship between storage deficit and discharge to estimate total storage at a hypothetical nearly zero flow condition. Third, we compared the pre-hydrological states and event runoff ratios (Q/P) to the catchments' physiographical conditions in order to link catchment's sensitivity to storage metrics. We then assessed the responsivity and elasticity to climate and anthropogenic variations – as expressed through the PET/P and AET/P deviations from the Budyko curve and energy limits– for each individual catchment. Finally, we investigated the catchment's area control on responsivity, elasticity, water yields and Budyko's elements across our set of 41 nested catchments.