Towards a better understanding and modelling of Hortonian overland flow during flash flooding

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In the last decade, several small-scale flash floods in south-west Germany have shown that there is great danger due to quickly rising water levels and soil erosion (BRONSTERT ET AL., 2018). Flash floods are triggered by high intensity rainfall events, where rapid surface (Horton) or shallow subsurface flows dominate runoff generation. Especially surface runoff can result in great damage as it is a highly localized process with large potential to perform physical work on the landscape and on infrastructure. Model characteristics can vary greatly in space and time, reliable predictions remain challenging, especially if hydrological models are applied, based on empirical rainfall-runoff relationships. It is hence a long-standing vision to use models which are more physically based and rely on less empirical relations, to be able to improve our ability to predict the occurrence and dimension of flash floods.

In this study we use the physically based model CATFLOW, which is firstly setup to simulate flash floods for a small rural catchment. We perform virtual experiments to test a) if the model is capable to predict two observed flash floods caused by two convective rainfall extremes and b) which model landscape characteristics are the most sensitive. Thirdly, we provide evidence that different standardized temporal rainfall patterns used in flood design strongly affect simulated flooding when being compared to simulations with the real observed pattern. Last, we discuss why the two observed flash floods differed strongly in peak and volume, although the two convective events were similar in depth, duration and mean intensity and antecedent wetness was similar as well. We assume that due to the lower degree of plant cover during the earlier first event, the likelihood for raindrops hitting bare soil was higher, causing more surface sealing and hence more surface runoff occurred. Plant cover influencing soil resistance and soil texture are besides meteorological forcing a main control of flash floods.