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Deriving rainfall thresholds and soil moisture conditions for flash flood warning in a forested catchment using a physical process-based model

Thanh Thi Luong, Rico Kronenberg, Judith Lorenz, and Christian Bernhofer

Technical Universtiy of Dresden, Environmental Science, Meteorology and Hydrology, Tharandt, Germany (thanh_thi.luong@tu-dresden.de)

The rainfall amount that causes flooding for a given basin area and precipitation duration is defined as rainfall threshold. Using rainfall thresholds for the development of flash flood warning systems is recommended by the WMO and commonly applied by civil protection agency to issue alerts. The estimated rainfall threshold is compared to either real-time-observed or forecasted rainfall to evaluate the risk of flooding.
To derive the flash flood rainfall threshold, the physically based lumped parameter model BROOK90 is applied to estimate the amount of rainfall that, for a given duration and initial soil moisture, causes high discharge. The model can represent well evapotranspiration (ET) by applying Shuttle and Wallace method for separating transpiration and soil evaporation which allows to estimate pre-event soil moisture more accurately. Daily meteorological measurements are required as model inputs in which precipitation and maximum and minimum temperature are mandatory. Moreover, the water balance processes such as interception, soil water movement and discharge can be further investigated in finer scale by higher resolution of precipitation input.
In this study, the model runs on hourly time step and the output is investigated in five different durations: 1, 3, 6, 12 and 24 h. Flooding events are identified and classified by initial soil moisture to reduce the uncertainty associated with non-linearity of the rainfall–discharge process. Contingency tables are used to estimate the quality of a deterministic forecast system. The methodology is then tested for the “Wernersbach” catchment in Tharandt forest taking advantages of the long term measurements since 1968 and meteorological measurements from “Anchor station Tharandt, “Grillenburg” and “Wernersbach” are applied. The first results are presented for main flood events in the 13- year period from 1997 to 2010.
BROOK90 is evaluated as possible tool to derive pre-event soil moisture and serve as potential input for flash flood guidance. The model limitations and strengths are considered and addressed.