Study of runoff generation responding to varied catchment morphology

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Hydrological processes are inevitably related to the catchment morphology, which includes hillslope, area, shape and drainage network, etc. The topic has attracted attentions of numerous studies on it. The previous studies mostly compare runoff generation processes in various catchments to derive empirical equations. However, due to the variability of catchment properties and climate conditions, it is highly possible that other factors would compound the results when one tries to focus on one particular catchment property. In this study, virtual catchments are built based on an actual catchment, the Brue catchment in UK. These catchments are assigned with varied morphology, including hillslope, area, width and length etc., and are simulated using a fully distributed model. When one catchment property is tested, the other properties are assumed as control variables. The whole hydrological processes are compared among all the catchments, in which the time to peak (Tp) and peak volume (Qp) are mainly considered as the assessment indicators. The results show that catchment morphology has significant influence on runoff generation. To illustrate, when the average slope of the catchment increases, the peak volume increases and the time to peak decreases following particular curves. Moreover, when the slope increases to a certain threshold level, the influence of slope on runoff generation is plateaued. An empirical model is built according to the results, which is able to provide a useful guide for runoff generation in varied catchments.