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Modelling surface stream and underground channel flow in response of rainfall under sinkhole effect in a karst catchment of southwest China

Zhicai Zhang, Xi Chen, and Chris Soulsby
Hohai University, Nanjing, China (zhangzhicai_0@hhu.edu.cn)

Detailed simulation of hydrodynamics in karst areas is extremely tough because of strong heterogeneity of geology and geomorphology, e.g. rock fractures and sinkholes, and a dual flow system of surface stream and underground channel. In this study, the distributed hydrology-soil-vegetation model (DHSVM) is improved to simulate both surface stream flow and underground channel flow and to quantify sinkhole effects on collecting overland flow and subsurface flow. The model has be successfully applied in the karst watershed of Houzhai, a typical karst watershed located in Guizhou province of southwest China, with detailed observation data of surface stream and underground channel flow, hydraulic properties of soil and fractures and karst topography. The model parameter sensitivity and simulation uncertainty regarding surface stream and underground channel flow are executed using Monte Carlo simulation. The results indicate that the surface streams located in relatively thick soil in the north of the watershed primarily receives overland storm flow, while underground channels in the south obtain the incepted overland flow, and subsurface flow from soil, epikarst and deep aquifer flow. It is found that sinkholes in the karst watershed play an important role in transferring overland flow into underground flow. The model simulation results indicate that the underground channel flow peaks are noticeably reduced due to the large proportion of overland storm flow intercepted by sinkholes in the eastern mountainous area of watershed. Meanwhile, water amount recharging into the underground channel via sinkholes is proportional to the rainfall amount.