ABSTRACT

Highly parameterized, physically based models may be no more effective at simulating the relations between rainfall and outflow from karst watersheds than are simpler models. Here an antecedent rainfall and convolution model was used to separate a karst watershed hydrograph into two outflow components: one originating from focused recharge in conduits and one originating from slow flow in a porous annex system. In convolution, parameters of a complex system are lumped together in the impulse-response function (IRF), which describes the response of the system to an impulse of effective precipitation. Two parametric functions in superposition approximate the two-domain IRF. The outflow hydrograph can be separated into flow components by forward modeling with isolated IRF components, which provides an objective criterion for separation. As an example, the model was applied to a karst watershed in the Madison aquifer, South Dakota, USA. Simulation results indicate that this watershed is characterized by a flashy response to storms, with a peak response time of 1 day, but that 89% of the flow results from the slow-flow domain, with a peak response time of more than 1 year. This long response time may be the result of perched areas that store water above the main water table. Simulation results indicated that some aspects of the system are stationary but that nonlinearities also exist.