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A Cellular Automata Based Model for Simulating Surface Hydrological Processes in Catchments

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The Runoff Model Based on Cellular Automata (RunCA) has been developed to simulate the surface hydrological processes at the catchment scale by integrating basic cellular automata (CA) rules with fundamental measureable hydraulic properties. In this model, a two-dimensional lattice composed of a series of rectangular cells was employed to cover the study area. Runoff production within each cell was simulated by determining its water depth based on the rainfall, interception, infiltration and the balance between inflows and outflows. Particularly different infiltration equations were incorporated to make the model applicable for both single rainfall event (short term simulation) and multiple rainfall events (long term simulation). The distribution of water flow among cells was determined by applying CA transition rules based on the improved minimization-of-difference algorithm and the calculated spatially and temporally varied flow velocities according to the Manning's equation. RunCA was tested and validated at two catchments (Pine Glen Basin and Snow Shoe Basin, USA) with data taken from literature. The predicted hydrographs agreed well with the measured results. Simulated flow maps also demonstrated the model capability in capturing both the spatial and temporal variations in the runoff process. Model sensitivity analysis results showed that the simulated hydrographs were mostly influenced by the input parameters that represent the final steady infiltration rate, as well as the model settings of time step and cell size. Compared to some conventional distributed hydrologic models that calculate the runoff routing process by solving complex continuity equations, this model integrates a novel method and is expected to be more computationally efficient as it is based on simple CA transition rules when determining the flow distribution.