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Simulation of Loess Gully Evolution Based on Geographic Cellular Automata

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Gully development is an important topic in the evolution of modern geomorphology. The study of the development process of gullies is key to explain the genesis, mechanism and spatial differentiation of loess geomorphology. Geographic cellular automata (Geo-CA) can simulate complex geographical phenomena by expanding and elements of Cellular automata (CA). This study explores the mechanism of the development process of loess gullies while taking into account the dynamic factors of head-cut erosion. Based on geographic cellular automata (Geo-CA), the transition rules for gully evolution are designed, including the rules of gully head region, the rules of water infiltration, flow direction rule, flow rules, and sediment transport rules. Based on the small simulated Loess watershed under artificial rainfall, the simulation model of loess gully evolution is constructed and implemented. In order to evaluate the accuracy of the simulation results, the negative terrain, Hypsometric Integral (HI) and a gully head confusion matrix of the simulated results and the measured data are compared. The evaluation produces encouraging results in terms of numeric accuracy and spatial distribution, in agreement with the evolution of the loess gully. In addition, the simulation model of loess gully evolution this study proposed is applied to the evolution of a natural watershed, the Madigou watershed located in Jingbian County, Yulin City, Shaanxi Province. The comparison between the simulated results of the model and the measured data is used to verify the validity of the model. All the results show that the evolution model of loess gully based on Geo-CA is satisfactory in simulating the process of loess gully evolution, which provides a new research method and ideas for in-depth study of the process of gully evolution.