Effects of a check dam system on the runoff generation and concentration processes of a catchment on the Loess Plateau

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As important soil and water conservation engineering measures, there are more than 100,000 check dams constructed on the Loess Plateau; these dams play a vital role in reducing floods and sediment in watersheds. However, the effects of check dams on hydrologic process are still unclear, particularly when they are deployed as a system for watershed soil and water management. This study examined the watershed hydrologic process modulated by the check dam system in a typical Loess Plateau catchment. By simulating scenarios with various numbers of check dams using a distributed physical-based hydrological model, the effects of the number of check dams on runoff generation and concentration were analyzed for the study catchment. The results showed that the presence of check dams reduced the peak discharge and the flood volume and extended the flood duration; the reduction effect on peak discharge was most significant among the three factors. The system of check dams substantially decreased the runoff coefficient, and the runoff coefficient reduction rate was greater for rainstorms with shorter return periods than for rainstorms with longer return periods. The check dams increased the capacity of the catchment regulating and storing floods and extended the average runoff concentration time in the catchment that flattened the instantaneous unit hydrograph. This study reveals the influencing mechanism of check dams on the hydrological process of a watershed under heavy rainstorm conditions and provides a theoretical basis for evaluating the effects of numerous check dams on regional hydrology and water resources on the Loess Plateau.