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Characteristics and mechanism of a catastrophic landslide-debris flow disaster chain triggered by extreme rainfall in Shaanxi, China

Jiewei Zhan and Zhaowei Yao
Chang'an University, Xi'an City, China (zhanjw@chd.edu.cn)

On October 5, 2021, a landslide-debris flow disaster chain occurred suddenly in Hanping village, Shaanxi Province, China. This catastrophic disaster chain damaged 7 houses, 41.9 hectares of arable land and 3 roads and resulted in 1 death. Based on a detailed field investigation of the disaster site, we analyzed the dynamic evolution of the disaster chain by using experimental analysis, unmanned aerial vehicle (UAV) photogrammetry, satellite remote sensing interpretation and the SBAS-InSAR technique and then preliminarily revealed the movement process and causal mechanism of the disaster chain. The results suggested that the first landslide initiated in the upper part of Canger cliff, which is the result of the combined effects of slope structure, earthquake damage, engineering disturbance, and rainfall infiltration. Among them, extreme rainfall events are the primary factors that induce landslides. Before the landslide, InSAR results showed that deformations had already appeared in the source area, and the deformation rate had a strong correlation with precipitation. Then, the potential-to-kinetic transformation effect and air cushion effects generated by the landslide movement in the narrow and steep section of Canger cliff led to the disintegration of the sliding body. With replenished surface runoff, the clastic flow gradually transformed into debris flow. Moreover, due to the dam-breaching effects at bayonets and bends and the entrainment effect of the high-density debris flow along the gully, the scale of debris flow increases gradually, resulting in catastrophic damage during the movement. The findings of this study provide a significant reference and guidance for understanding the chain-generation mechanism of landslide-debris flow disaster chains, as well as informing disaster prevention and mitigation strategies.